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MATERIALS SCIENCE AND METALLURGY

No. 61

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USSR REPORT
MATERIALS SCIENCE AND METALLURGY

No. 61

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USSR

UDC 669:74:539.376

CREEP AND DESTRUCTION OF ALUMINUM IN THE TEMPERATURE RANGE OF 77-273°K

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 1, Jan 79
pp 164-170 manuscript received 21 Dec 77, after revision 15 Mar 78

DEMIKHOVSKAYA, N. N. and KUROV, I. YE., Gor'kiy State University imeni N. I. Lobachevskiy

[Abstract] An investigation is made of the dependence of durability and steady-state creep rate on stress under conditions of uniaxial tensile loading in the temperature range of 77-273°K. The material for the studies was aluminum of 99.96% purity. The specimens were pretreated by annealing at 823°K for one hour plus deformation by 25% at 77°K plus aging at room temperature for 100 hours. Test temperature was held within $\pm 2^\circ\text{C}$. The value of energy of activation of destruction and creep is determined and found to agree closely with double the energy of formation of a step on a dislocation. Analysis of the results describing destruction and creep of aluminum at low temperatures shows that under the given experimental conditions the strain process is predominant and determines the process of destruction. Figures 6; references 15 (Russian).

USSR

UDC 669.71:669.046.552.3

ON THE DEVELOPMENT OF SECONDARY HYDROGEN POROSITY IN ALUMINUM

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 160-164 manuscript received 18 Oct 77

ANTIPIN, V. P., Moscow

[Abstract] Samples were annealed at 520°C for 5 hours, then transferred to a furnace at 580°C. Test samples consisted of cast 99.99% pure aluminum that was saturated with hydrogen at 750°C and a hydrogen pressure of 500 mm Hg. To prevent hydrogen loss during annealing the samples were coated with an anode film in a solution of boric, oxalic, and chrome oxides. Changes in porosity were then measured on the basis of the density of the aluminum by weighing in air and in diethylphthalate. Results of this stage of the experiment did not confirm the increase in porosity expected. A second stage tested non-anodized samples at a residual pressure of 10^{-5} mm Hg and a temperature of 580°C for 4 hours. After annealing, the porosity of these samples decreased from 0.20 to 0.11%. Hence the increase in porosity is shown to be related to diffusion creep, with the presence of a balance between hydrogen in the pores of the metal and in the metal structure. Figures 3; references 10: 7 Russian, 2 English, 1 German.

USSR

UDC 669.715:539.56:620.194.2

ON THE SUBCRITICAL CRACK GROWTH IN ALUMINUM ALLOYS IN THE STATIC PLANE STRESS STATE

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian No 1, Jan/Feb 79
pp 10-12 manuscript received 16 Nov 77

NESHPOR, G. S., All-Union Institute of Light Alloys, Moscow

[Abstract] Studies were performed of the growth of cracks in aluminum alloys under long-term static plane stress. The specimens tested were 80-100 mm wide, 400 mm long and 2-3 mm thick, with a central fatigue crack about 40 mm in length. The specimens were made of the alloys D16T, D16T1, AMg6P, and V95T1. It was found that, contrary to opinions widely expressed in the foreign literature, subcritical crack growth does occur under long-term static plane stress. Figures 2; references 6: 5 Russian, 1 Western.

USSR

UDC 669.715:62-492.3.620.17:620.18

STRUCTURE AND PROPERTIES OF Al-W, Al-Mo, AND Al-Nb ALLOYS PRODUCED FROM GRANULES

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, 1979 pp 39-41

FEDOROV, V. M. and YELAGIN, V. I., All-Union Institute of Light Alloys

[Abstract] This work is a continuation of an earlier study (Dobatkin, Fedorov and Yelagin, IZVESTIYA AN SSSR. METALLY, 1969, No 5) which showed that anomalously supersaturated solid solutions of refractory transition metals (Mn, Cr, Zr, Ti, and V) in aluminum may contain up to 5% Mn, 2% each of Cr and Zr, and 1.2% each of Ti and V. In this connection, binary Al alloys treated with virtually insoluble refractory metals Nb (0.24-1.1%), W (0.5-1.38%) and Mo(0.12-0.83%) were investigated. Alloy granules of 1-2-mm diameter were cast by the centrifuging method. Granules of alloys of the Al-W system containing up to 1.2% W display a homogeneous cellular structure. Further addition of W results in the formation of primary intermetallic compounds, which leads to a sharp impoverishment of the supersaturated solid solution at which point the properties of the alloys approximate the properties of pure aluminum. Similar investigation of the microstructure, lattice parameter, electrical resistance, and microhardness of the alloys with Mo and Nb showed that anomalously supersaturated solid solutions lacking primary intermetallic compounds form in the presence of $\leq 0.62\%$ Mo and 0.75% Nb.

(Anomalously supersaturated solid solutions are construed as solid solutions in which the actual concentration is several times as high as the maximum solubility according to the equilibrium diagram of state obtained on quenching from the liquid state.) The anomalously supersaturated solid solutions of W, Nb, and Mo in Al which form during granulation are sufficiently stable. The temperature of the onset of segregation of intermetallic compounds from the matrix is 600-670°C which greatly exceeds the temperature of the onset of the decomposition of solid solutions of such transition metals as Mn, Cr, Zr, Ti, and V in aluminum. The maximum strength of the investigated alloys at high temperatures (350°C) is 7-8 kg/mm², which corresponds to the properties of the best heat-resistant aluminum alloys. Stress-rupture strength tests of W, Mo, and Nb containing Al alloys at 350°C show that they are softened at a slower rate than Al alloys treated with other transition metals (Cr, Ti, V). Figures 2; references 2 (Russian).

USSR

UDC 539.434:539.376:669.715

STRESS-RUPTURE STRENGTH AND CREEP OF ALUMINUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, 1979 pp 28-30

MAKHUTOV, N. A., KOPYLOV, A. K. and FROL'TSOVA, T. A.

[Abstract] Although the stress-rupture strength (SRS) and creep of Al alloys at high temperatures of 150-250°C are now well-known, knowledge of these properties at room temperatures is still limited. To fill this gap, the SRS and creep of the aluminum alloys AMg6 (Al-Mg system), "1201" (Al-Cu-Mn system) and "1911" (Al-Zn-Mg system) at room temperatures were investigated by means of static loading tests and destructive creep tests. A formula for representing the findings of long-term static loading tests in the form of isochronous curves of deformation is proposed with the object of estimating the strength margin and the dependence on loading time. It is established that increasing the static loading time of the three aluminum alloys to 2000 hr at room temperature reduces their strength characteristics by 10-20% and plasticity characteristics by 10-15%. The buildup of creep flow markedly increases with an increase in the loading stresses applied (≤ 40 kg/mm²) and is characterized by isochronous strain curves in accordance with which the resistance to plastic flow (commensurate with deformation corresponding to yield point) decreases by 10-15% with an increase in loading time. Figures 5; references 7: 6 Russian, 1 Western.

ON THE POSSIBILITY OF DISTRIBUTING THE INTERNAL FRICTION COMPONENTS IN THE EARLY STAGE OF ALUMINUM PLASTIC DEFORMATION

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 3, Mar 79
pp 620-625 manuscript received 31 Jan 78

ZHUKOV, S. V. and TERMINASOV, YU. S., Kuybyshev Polytechnical Institute
imeni V. V. Kuybyshev

[Abstract] A method is presented for the quantitative determination of the internal friction components of aluminum. This method is based on being able to measure the internal friction function related only with the detachment of dislocations from the points of their attachment. Experiments to check this method were conducted at room temperature on single and polycrystalline A995 aluminum and A995 alloyed with magnesium. Samples were annealed for two hours at 400°. The experiment was conducted by applying a specific load to the sample for such a time that the coefficient of damping was regulated to depend on time. Then the load was quickly removed and the sample kept unloaded until the damping regulation was time independent, after which the sample was again loaded. The constituent coefficients of damping, associated with detachment of dislocations from their moorings and with the propagation of dislocations, were found respectively by the change in the ultrasonic damping factor at the moment of unloading and the difference between the damping factor changes at the moment of loading and unloading. It was found that the damping factor is significantly reduced with increasing magnesium content and the maximum load before reaching the damping factor peak is also increased with increased Mg content. Dislocation propagation is also lessened with increased Mg content. Thus the greater the Mg content the greater the load required to detach dislocations. Figures 6; references 12: 6 Russian, 6 Western.

USSR

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METHODS AND MEANS OF NONDESTRUCTIVE TESTING AND WAYS OF THEIR DEVELOPMENT

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, 1978 pp 109-115

ZATSEPIN, N. N., Physics of Nondestructive Testing Section of the Academy of Sciences Belorussian SSR

[Abstract] The following nondestructive test methods and areas of their application are reviewed: magnetic particles methods (ferrozondes, magnetographical, pondermotive, residual magnetization); electromagnetic (eddy currents, higher harmonics, Berkhausen effect, vibrational); ultrasonic (contact and electro-magnetic-acoustic); thermoelectric, thermal, radio waves, holography, and high-speed photography. The study of nonlinear electromagnetic processes is one of the prospective directions in the area of nondestructive testing methods. The new trend in the development of nondestructive test methods is the use of computers in automatic test units, miniaturization of test devices for manual testing, separation of useful signals from noise, development of a general theory of the measurement converters and computing the converter parameters. Ultrasonic and eddy currents methods are widely used in atomic reactors where high temperatures (1000-1200°C) are an obstacle for other methods. Studies of nondestructive testing are concentrated in the USSR at the NIIIN [expansion unknown] (Moscow), VNIINK [expansion unknown] (Kishenev) and the Ural Scientific Center of the Academy of Sciences USSR (primarily for the development of the magnetic particles methods).

USSR

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COULOMETRIC DETERMINATION OF CHLORIDE IONS IN SPONGE TITANIUM

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 45 No 2, 1979 pp 100-101 manuscript received 16 Dec 77

SERIKOV, YU. A., ROZHKOVA, YE. A., All-Union Scientific Research and Planning Institute of Titanium, Berezniki Branch

[Abstract] A study was made of the conditions of determination of chlorine in sponge titanium using a type T-201 laboratory coulometric titrator. The method of using the device for analysis is described. It is found that the method is applicable for determination of chlorine in the range of 0.01-0.40%. The time required for a single determination is 15-20 minutes, and a laboratory worker using a single titrator can perform as many as 150 determinations per working shift.

ON METHODS FOR INVESTIGATING THE MECHANICAL PROPERTIES OF COMPOSITE MATERIALS UNDER CONDITIONS OF COMPLEX STRESSED STATE

Kiev PROBLEMY PROCHNOSTI in Russian No 4, 1979 pp 90-93 manuscript received 29 Jul 77

VOLOSHCHENKO, A. P., ALEKSYUK, M. M., PETRENKO, A. I., ROMANOV, D. I. and LOKSHIN, V. A., Kiev and Obninsk, Institute of Problems of Strength, Academy of Sciences UkrSSR

[Abstract] So far the facilities used in the Soviet Union to induce a complex-stressed state in test specimens have been built individually rather than series-produced and, what is more, they are used to test metals only, not other materials. Yet, although the mechanical tests of plastics are basically done by the same methods as the tests of metals, allowance must be made for specific structural features of polymeric materials (distinct anisotropy, complexity of inhomogeneous structure, etc.). In this connection, the SN-10P facility for testing composite materials in complex-stressed state has been developed at the Institute of Problems of Strength, Academy of Sciences, UkrSSR. The SN-10P is designed for the special testing conditions required by polymeric materials (different manner of clamping, of measuring specimen deformation, and testing at high temperatures, at which the constancy of the temperature regime must be maintained more rigorously than in the case of metals). The SN-10P test stand consists of a hydraulic testing machine, a specimen chamber, a vacuum system, a high-pressure unit for creating pressure within or without the specimen, cooling and heating systems, a strain-measuring system, and a control system. The maximum axial stress and torque that can be applied to specimens on this test stand are 10,000 kg and 8,000 kgcm, respectively, and the temperature range of tests is from -190 to +800°C. The test stand assures a broad spectrum of loadings (axial tension and compression, internal and external pressure, torsion), both separately and together. It has been used to test tubular specimens of glass plastics and carbon glass plastics with satisfactory results. The design of the special clamp for testing tubular specimens under varying loads is described. Formulas for determining the steady-state temperature inhomogeneity over the specimen's length at low and high temperatures are presented. Figures 4; references 3 (Russian).

LOW-FREQUENCY ACOUSTIC METHODS OF NONDESTRUCTIVE INSPECTION

Sverdlovsk DEFECTOSKOPIYA in Russian No 9, Sep 78 pp 22-36 manuscript received 26 Apr 78

LANGE, YU. V. and MOSKOVENKO, I. B., Scientific Research Institute of Internal Inspection, Moscow, All-Union Scientific Research Institute of Abrasives and Grinding, Leningrad

[Abstract] A survey is made of major low-frequency methods of nondestructive inspection that have been developed and put into practice principally over the last two decades. No coverage is given to the use of elastic oscillations in traditional methods (shadow, echo, resonance), only fundamentally new techniques or radical improvements in conventional methods being considered. Common features of the methods examined are the use of elastic vibrations in the audible and low ultrasonic frequency range (up to 100-150 kHz), and dry contact between the emitting and receiving transducers and the surface being inspected in a small area--the so-called dry point contact. In contrast the classical ultrasonic inspection methods that use mainly body waves (longitudinal and transverse), low-frequency technique use mainly more complicated wave modes--flexural, normal and so on. The problems of nondestructive inspection of laminar metallic and nonmetallic materials are discussed. The most extensively used method for inspecting such materials in the Soviet Union is the impedance method, in which a flaw is detected from the change in mechanical impedance of the inspected item in the zone of contact with a transducer that excites audible vibrations in the part. Flaw detectors based on this principle are series produced by the Elektrotekhnicheskii Plant in the IAD series. The amplitude method is a modification of the impedance method that differs in the method of determining mechanical impedance. This technique can detect separation of layers and broken welds to a depth of 15 mm. However, this method is not as sensitive to small flaws close to the surface. The velocimeter method utilizes the influence of flaws on the rate of propagation of elastic waves in an item, and also the length of the wave path between emitter and pickup. Various modifications of the phase and time velocimeter methods are considered. The acoustic spectral method is based on the principle of recording the changes in acoustic spectra due to distortion by flaws. The technique can detect flaws at depths up to 30 mm. Production of the first series-produced spectral flaw detector--the AD-50U--was organized in 1978. One of the newest tools for flaw detection of multilayered parts is the acoustic-topographic method. Elastic oscillations are excited in the inspected part on a wide frequency range, and the amplitudes of oscillations from sections cut off by the flaws are amplified as a consequence of resonances. Inspection results show the location, configuration and sizes of flaws. Figures 9; references 70: 54 Russian, 16 Western.

EVALUATION AND ANALYSIS OF THE SENSITIVITY OF MONOENERGETIC ELECTRON INSPECTION OF COMPOSITE MATERIALS WITH FLUCTUATING COMPOSITION

Sverdlovsk DEFECTOSKOPIYA in Russian No 9, Sep 78 pp 72-82 manuscript received 6 Apr 77

RUDENKO, V. N. and YUNDA, N. T., Scientific Research Institute of Electronic Internal Inspection, Tomsk

[Abstract] An analysis is made of the procedural error in the radiometric method of thickness measurement for composite materials exposed to monoenergetic electrons with energy of 25-30 MeV. In the case of composite materials with surface density of less than 7-10 g/cm², the method of electron radiography is superior to x-ray techniques in high sensitivity and low procedural error. The chief advantage of the electron method for materials with greater surface density is its sensitivity. The maximum procedural error is reached in the case of materials with predominant contribution of a component with high molecular weight. This is the direct opposite to the case of x-ray radiography where maximum sensitivity is reached with a heavy component making up several percent of the surface density. The use of an induction accelerator source--a betatron with energy of up to 30 MeV--enables inspection of materials with a surface density of up to 15 g/cm². Figures 8; references 11: 9 Russian, 2 Western.

USSR

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INVESTIGATION OF THE STRENGTH OF THE BONDING OF MULTILAYER COATINGS TO ALUMINUM-ALLOY SURFACE

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 1979
pp 124-127 manuscript received 15 Oct 76

PUSTOTINA, S. R., SOLOV'YEV, V. M., NOVIKOV, N. N., KABANCHENKO, M. P. and
PISKAREVA, N. M., Odessa and Moscow

[Abstract] The cermet and ceramic coatings applied to metals with the object of increasing their wear resistance and heat resistance must be firmly bonded to metal surfaces in order to withstand drastic variations in temperatures, impact loads, and vibrations, but this is not always possible owing to incompatibility between the physical properties of the coating and the metal, especially in the case of aluminum and magnesium alloys. In this connection, a technique for assuring reliable adhesion of a multilayer plasma coating to AK-4 aluminum alloy is described. This can be accomplished through the chemical deposition of an intermediate 0.03-0.04-mm-thick layer of nickel to counteract the effect of the oxide MgO which prevents a firm bonding to the cermet coating. It is shown that in analyses of adhesion interactions in the coating-substrate contact zone allowance should be made for the thickness and phase of surface films on the base. It is also expedient to apply the cermet coating in the form of a composite powder rather than a mechanical mixture, since then the Ni-Al powder layer can be excluded from the multilayer coating. Then adhesive strength is several times as high as in direct deposition of a mechanical mixture of the cermet onto the Ni-P substrate. References 6: 5 Russian, 1 Western.

USSR

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PRODUCING FILMS AND COATINGS BY USING CONCENTRATED ENERGY SOURCES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 79 pp
3-11 manuscript received 5 Dec 77

RYKALIN, N. N., UGLOV, A. A. and ZUYEV, I. V., Moscow

[Abstract] A survey is made of some of the particulars of the process of vapor phase production when lasers and electron beams act on materials in pulsed thin-film sputtering and surfacing. One of the big advantages of the pulsed method of sputtering is the high rate of film deposition--1-10 $\mu\text{m/s}$. Pulsed methods also provide films with compositions closer to the stoichiometric makeup than do steady-state techniques. The authors discuss some

of the problems of transporting the vaporized material from the zone of action of the energy source. An examination is also made of experiments on depositing a number of metals on glass substrates by using a pulsed electron beam. Principal types of installations for producing vapor flows are discussed. The particulars of processes of condensation under conditions of pulsed sputtering are considered. The problem involved in research on processes of sputtering and the particulars of condensation are discussed. Specifically, the use of pulsed concentrated flows for technological purposes necessitates theoretical and experimental investigation of the kinetics of sputtering with consideration of the influence of the parameters of the energy source and the characteristics of the material being vaporized. Factors that must be determined include the proportion of surface and volume vapor formation processes, the velocity of particles in the vapor flow, the degree of particle dispersion, ionization, spatial distribution and so forth. There has not been enough research done on some of the particulars of the condensation process that result from the high rate of deposition: an increase in the number of nucleation centers, increased adhesion and so on. Technological flaws (droplets) and defects of vacancy-diffusion origin (macropores up to 3 μm in diameter, pits) that show up after cyclic heat treatment affect the quality of the resultant coatings. These phenomena must be taken into consideration, and where necessary the diffusion mobility of the atoms should be reduced by doping, using multilayered coatings and so forth. Figures 3; references 55 (Russian).

USSR

UDC 669.017:539.56

FRACTURE OF A DIRECTIONAL CRYSTALLIZED LAMELLAR EUTECTIC COMPOSITE Ni_3Al - Ni_3Nb DURING DYNAMIC BEND

Minsk IZVESTIYA AKADEMII NAUK BSSR. SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, Apr 79 pp 52-56 manuscript received 6 Feb 78

NESTEROVICH, L. N., GAZOV, V. I., KUPCHENKO, G. V. and GUZ', I. S., Physico-Technical Institute, Academy of Sciences Belorussian SSR, Ukrainian Scientific Research Institute of Metals and Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] An attempt was made to produce a ductile eutectic Ni_3Al - Ni_3Nb composite by directed crystallization and to study the nature and kinetics of fracture in the composite during dynamic bend. It was found that samples with a regular structure possess a much longer time to failure than those without. The process of failure in the composite occurs by quasi-brittle, quasi-ductile micromechanisms and a mixture of the two. It was confirmed that each constituent of the composite plates fractures according to a definite micromechanism, with Ni_3Al being the quasi-ductile component. Figures 3; references 5: 4 Russian, 1 Western.

USSR

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STRUCTURAL STABILITY OF ALUMINUM-BORON AND ALUMINUM-SILICON CARBIDE COMPOSITES AT HIGH TEMPERATURES

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 1, Jan/Feb 79 pp 49-52 manuscript received 27 Dec 76

MAKSIMOVICH, G. G., FILIPOVSKIY, A. V., LYUTY, YE. M., Physico-Mechanical Institute, Academy of Sciences Ukrainian SSR, L'vov

[Abstract] A study is made of the influence of holding at high temperatures on the structure and properties of aluminum-boron and aluminum-silicon carbide fiber composites. The matrices were AMg_3 and AMg aluminum alloys, with fibers of boron and silicon carbide 100 μm in diameter, made by precipitating a layer of boron or silicon carbide onto a central core of tungsten (12.5 μm in diameter). The boron composite retains its strength properties when held at 300°C for 500 hours, or at 400°C for 100 hours, but loses about one-third of its strength when held at 400°C for 500 hours, and still more when higher temperatures are used. The silicon carbide composite retains its strength at 500-580°C for long periods of time. Its superior performance results from the lower reactivity of the SiC fibers with the aluminum matrix. Figures 2; references 10: 4 Russian, 6 Western.

TITANIUM DIOXIDE-BASE STRUCTURAL CERAMIC

Moscow STEKLO I KERAMIKA in Russian No 3, Mar 79 pp 21-22

KARPINOS, D. M., Doctor of Technical Sciences, GUMENYUK, YE. L. and KALINICHENKO, V. I., Engineers, and GROSHEVA, V. M., Candidate of Technical Sciences, Institute of Problems of Material Science, Academy of Sciences, UkrSSR, Ukrstroykeramika Union

[Abstract] An attempt was made to produce a TiO_2 -base structural material with high strength properties by hot extrusion using whiskers of mullite as the reinforcing fiber. The process was done at 1500°C under a pressure of $150\text{--}200 \text{ kgf/cm}^2$ for 10-15 minutes using a mixture of 75-85% TiO_2 and 15-25% mullite. Test data showed that the mechanical properties and chemical stability of the reinforced TiO_2 were much higher than the unreinforced ceramic. Whiskers of other refractory compounds ($\alpha\text{-Al}_2\text{O}_3$, SiC , Si_3N_4 and ZnO) were also tested where the $\alpha\text{-Al}_2\text{O}_3$ was found to be best as a reinforcing fiber, even better than mullite. Figure 1; references 5: 2 Russian, 3 Western.

THERMODYNAMIC METHOD OF CALCULATING THE INFLUENCE OF DOPANTS ON INTERPHASE INTERACTION IN COMPOSITE MATERIALS

Moscow FIZIKA I TEKHNIKA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 78 pp 121-126 manuscript received 21 May 78

TYCHINSKIY, L. I., Kiev

[Abstract] A thermodynamic analysis is done on a composite material reinforced with fibers consisting of a single-component substance f . The matrix of the composite material is a solid solution based on a component in which small amounts of substance f and a dopant l are dissolved. It is assumed that during high-temperature interphase interaction it is only the fiber that dissolves in the matrix, while the components of the matrix alloy do not dissolve in the fiber. A quantitative thermodynamic criterion is found to determine whether a given dopant will accelerate or retard the dissolution of the fiber in the matrix without any special experiments. The key to the dissolution process is the difference in chemical potentials of the fiber substance in the matrix and in the fiber itself. The greater this difference, the more pronounced will be the dissolution. The difference in chemical potentials is calculated for substance f in a binary solution with the base

component, and in a ternary solid solution with the base component and dopant 1 that has the same atomic percentage of substance f as does the binary solution. Expressions are derived for thermodynamic coefficients that show the influence of dopants on the rate of dissolution of fibers in the composite material. The sign and absolute value of these coefficients can be used to compare the effect of different dopants on the rate of interphase interaction in composites. Experiments in doping nickel reinforced with tungsten fibers show qualitative agreement with the theoretical analysis. References 9: 7 Russian, 2 Western.

THE STATUS AND PROSPECTS FOR THE DEVELOPMENT OF ELECTRIC SLAG SMELTING (FROM MATERIALS OF THE ALL-UNION SCIENTIFIC AND TECHNICAL SEMINAR)

Moscow STAL' in Russian No 2, 1979 pp 118-120

LEYBENZON, S. A., Candidate of Technical Sciences, The "Dnepropetsstal'" Plant

[Abstract] Topics are summarized from the seminar held in the city of Zaporozh'ye in 1978, at which 120 participants addressed matters of interest for the development of electric slag smelting. The seminar was organized by "Soyuzspetsstal'" (All-Union Special Steel) of the USSR Ministry of Ferrous Metallurgy, by the Ukrainian Scientific Research Institute for Special Steels, and by the Ye. O. Paton Electric Welding Institute of the Ukrainian Academy of Sciences. Topics included synthesis of trends in the development of electric slag smelting, achievements in ingot size, quality improvement, automation, defect elimination, electronic problems, control of impurities, modernization, and improved efficiency of operation. Technological improvements, reduction in energy use, and alloying subjects were also described in the seminar papers. The participants resolved to increase steel production by electric slag smelting with existing and new facilities, to seek to reduce hydrogen content in produced steel, and to develop new fluxes.

USSR

UDC 669.71.017.539.43:539.219.02

STUDY OF THE CORROSIVE INFLUENCE OF THE ENVIRONMENT ON FATIGUE CRACK GROWTH RATE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian No 1, Jan/Feb 79
pp 12-15 manuscript received 27 Apr 78

YERMOLENKO, B. I.

[Abstract] A study is presented of the fatigue failure of structural materials in various corrosive media in comparison to the failure of the same materials in a vacuum. Flat specimens of thin sheet D16AT duralumin and VNS-2 steel with central notches were tested in a vacuum, in laboratory air, distilled water and a 3.5% aqueous solution of NaCl at loading frequencies of 14 and 25 Hz. Testing of the aluminum alloy in distilled water and the NaCl solution resulted in rapid liberation of hydrogen bubbles from the tip of the fatigue crack, as a result of the chemical reaction between the newly exposed surfaces and the water, producing aluminum hydroxide and hydrogen. As the loading frequency was decreased from 25 to 14 Hz in a vacuum, a slight decrease in fatigue crack growth rate was observed. In air, distilled water and the salt solution, decreasing the load frequency caused a significant increase in fatigue crack growth rate. An equation is derived, relating the growth rate to the number of cycles of loading. Figures 2; references 14: 8 Russian, 6 Western.

USSR

UDC 620.193.4

COMPARISON OF THE CORROSION RESISTANCE OF "4200" AND Ti-2% Ni TITANIUM ALLOYS IN CONCENTRATED CHLORIDE SOLUTIONS

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 2, 1979 pp 213-215 manuscript received 28 Nov 77

RUSKOL, YU. S., BURAYA, T. A., PARSHIN, A. G. and OGINSKAYA, YE. I., All-Union Scientific Research Institute for the Corrosion Protection of Metals

[Abstract] Corrosion resistance of "4200" alloy (Ti-0.2 Pd) and Ti-2% Ni alloy in HCl-acidified solutions of 25% NH_4Cl , 25% KCl, 30% BaCl_2 , and 30% MgCl_2 at 100°C in the presence of natural aeration was investigated by a technique described earlier (Yu. S. Ruskol et al. ZASHCHITA METALLOV, 15, 45, 1979). The tests served to determine the corrosion resistance limits of the

alloys in the chloride solution as a function of the HCl content of these solutions. The increase in corrosion resistance of "4200" and Ti-2% alloys compared with commercial-purity Ti differs for different chloride solutions. In NH_4Cl and BaCl_2 solutions the critical concentration of HCl for Ti-2% Ni is nearly the same, while in KCl and MgCl_2 solutions it is 3.6 and 6 times as high, respectively, as for commercial-purity titanium. The range of corrosion resistance for the "4200" alloy in all the investigated solutions is markedly broader than for both Ti and Ti-1% Ni alloy. For example, in MgCl_2 solution the critical concentration of HCl is 20 times as high for the "4200" alloy compared with the Ti-2% Ni alloy. On the whole, Ti-2% Ni alloy is markedly inferior to "4200" alloy in corrosion resistance in acidified chloride solutions, and its advantages over commercially pure Ti are limited. At the same time, the Ti-2% Ni alloy is distinguished by a particularly long (up to 250-300 hr) incubation period of corrosion prior to the onset of its active dissolution. Hence the determination of its corrosion resistance requires prolonged testing, as otherwise the conclusions concerning that resistance may be erroneous. Figures 1; references 7: 5 Russian, 2 Western.

USSR

UDC 620.193.41

CORROSION RESISTANCE OF BINARY ALLOYS OF TITANIUM WITH IRON

Moscow ZASHCHITA METALLOV in Russian Vol 15 No 2, 1979 pp 210-213 manuscript received 20 Oct 75

SHAPOVALOVA, O. M., ONISHCHENKO, T. N. and SHASHLO, O. YA., All-Union Scientific Research and Design Institute of Titanium

[Abstract] Fe, whether as an impurity or an alloying element, adversely affects the corrosion resistance of Ti alloys. In this connection, corrosion resistance in binary Ti-Fe alloys containing 0.1-10 mass% Fe was investigated on specimens in the cast state after forging at 920-950°C and heat treatment (quenching from 950°C in water, annealing in (α + β) region at 700°C for 30 min, cooling in air; annealing in β -region at 950°C for 20 min, cooling in furnace at 1.4°C/min). Corrosion was investigated during 1000 hrs by the volumetric method in 10% HCl at 25°C with replacement of solution once every 100 hrs. After the first 20 hrs, and thereupon through every 100 or 200 hrs the specimens were removed, dried, weighed and subjected to metallographic examination, x-ray spectral analysis, and photographing, along with plotting of anodic potentiometric curves in some cases. The x-ray spectral analysis showed that the Fe in Ti is very nonuniformly distributed and, at the same

time, that the metastable β -phase forms in the Fe-enriched sectors even in specimens containing extremely low mean Fe concentrations (0.1-0.3% Fe), regardless of the type of heat treatment of the alloy. Hence the observed deterioration in the corrosion resistance of Fe-treated Ti may be associated with the presence of metastable phases with electrochemical characteristics differing from those of the α -phase, and primarily with the Fe-concentrating β -phase. Thus corrosion in Ti-Fe alloys is of a selective nature, concentrating in the Fe-enriched sectors of these alloys, and is the greater the higher the Fe content is and hence also the higher the content of the β -phase is. The maximum Fe content at which a Ti alloy can still display the same corrosion resistance as commercially pure cast titanium (0.041 g/cm²·hr) is 0.7%. Hence it is safe to increase to 0.7% the Fe content of the Fe-containing Ti alloy scrap used for intricate-shape casting. The amount of the β -phase in such alloys does not exceed 3-5%. Figures 1; references 18 (Russian).

USSR

UDC 620.193.2

AN X-RAY ELECTRON SPECTROSCOPIC STUDY OF THE OXIDATION OF TITANIUM AND VT-5 ALLOY IN OXYGEN AND WATER VAPORS

Moscow ZASCHITA METALLOV in Russian Vol 15 No 2, 1979 pp 169-194 manuscript received 17 May 78

AKIMOV, A. G., ROZENFEL'D, I. L. and DAGUROV, V. G., Institute of Physical Chemistry, Academy of Sciences USSR

[Abstract] The initial stages of the oxidation of Ti markedly affect the mechanism of the corrosion cracking of that metal. In this connection, the interaction between oxygen-containing molecules and the surface of Ti alloys is investigated by techniques of x-ray electron spectroscopy for the first time. Vacuum-melted iodide titanium containing $\leq 0.01\%$ impurities as well as VT-5 Ti alloy containing $5.8 \pm 0.27\%$ Al plus $\leq 0.3\%$ other elements were oxidized in O₂ and water vapor under pressures of 10^{-7} - 10^{-5} torr at $T \approx 293^\circ\text{K}$. The most intense electron line Ti2p_{3/2} was the chief object of analysis.

It was established that interaction between Ti and O₂ results in the formation of a surface oxide with a composition close to that of Ti₃O₅. The quantity of O₂ on the surface of Ti in dry O₂ is twice as large as in H₂O, which is apparently due not only to the size of the adsorbing molecules but also to the thickness of the metal layer interacting with the oxidant. Interaction between Ti and H₂O vapors under the same conditions results in the formation of an oxygen compound containing Ti atoms in degrees of oxidation $\leq +4$, in an amount smaller than one monolayer, since then the oxygen intake

is half as large as for oxidation in molecular O_2 . The kinetics and basic patterns governing the oxidation of the VT-5 Ti alloy are analogous with the above. The proposed model of the surface of both the alloy and Ti oxidized in O_2 consists of a Ti_3O_5 monolayer at the metal-gas interface, beneath which Ti is oxidized to a suboxide (e.g. $TiO_{0.6}$) to a depth of 5-10 lattice constants. Figures 4; references 19: 6 Russian, 13 Western.

LASER TREATMENT OF MANMADE GRAPHITE MONOCRYSTALS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 79 pp 158-160 manuscript received 23 Aug 77

NIKOL'SKAYA, I. F., KISELEV, V. YU., POLOZHIKHIN, A. I. and NABATNIKOV, A. P., Moscow

[Abstract] Structural findings on the destruction of manmade graphite monocrystals by a focused laser beam are described. This material was selected in view of its technological potential. The specimens selected represented lamellar crystals with developed basal planes measuring 4-6 mm in length and 30 to 200 μ m in thickness. Their proneness to cleavage in the direction of basal plane impedes their cutting. Two types of laser treatment of these crystals were employed: 1) drilling of orifices with a solid-state laser (glass with neodymium) 2) cutting with a molecular-nitrogen laser. Following this treatment the crystals were examined with the aid of an MIM-8M metallographic microscope and a KVIKSKAN-100 scanning electron microscope. No cracks or other marked disturbances were observed on the basal surface in the neighborhood of the drilled apertures. The laser-treated areas were found to be covered by a film forming as a result of the condensation of carbon from the gaseous phase arising at the instant of treatment. This film can be removed by oxidation in air at 850°C for 1 hr. The cutting of the crystals into 10-15- μ m-thick fragments also was satisfactory on the whole. Thus the possibility of dimensional machining of graphite monocrystals by means of lasers is demonstrated. The inhomogeneity of vaporization in the zone of laser treatment is due to some defocusing of the laser beam and structural defects of the material. Figures 1; references 5 (Russian).

HEAT TREATMENT AND PROPERTIES OF EP557 ALLOY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, 1979 pp 58-61

TALAKIN, N. I., LASHKO, N. F., KARPOV, A. G., KOZLOVA, M. N. and GEYDYSH-SEMEENOVA, I. S.

[Abstract] The effect of heat treatment on the properties of the precipitation-hardened EP557 alloy of the Ni-Cr-Ta-Ti-Si system, used for the production of heat- and corrosion-resistant sensitive elements, is investigated. Vacuum-induction melted EP557 alloy having the mean chemical composition of 0.037% C, 18.88% Cr, 2.36% Ti, 10.02% Ta, 0.35% Fe, 1.03% Si, 0.0007% Pb, 0.008% P, 0.006% S, 0.00018% Bi, 0.013% Cu, 0.0005% Sb, 0.004% Sn, 0.009% O, 0.0012% H, and 0.0039% N, was used in the tests. The properties investigated were the aspects of hardening of the alloy, the kinetics of the segregation and dissolution of hardening phases in the course of heat treatment, and the relationship between structural transformations and mechanical properties. The microstructure, phase composition, and properties of the alloy were analyzed during tensile, bending, relaxation resistance, creep, and fatigue tests, following annealing and quenching from 950, 1080, 1100°C, and 1150°C. It was found that the alloy acquires a high plasticity, required for its rolling into strip or stamping into various shapes, when quenched in water from 1080-1100°C. This is accompanied by a marked dissolution of the intermetallic phases. The alloy then consists of ~92-93% of the gamma-solid solution, 6-7% of the intermetallic η -phase, and ~0.5% of carbides. Aging at 750°C can improve the elastic properties of the alloy, since it induces an intense decomposition of the solid solution, maximizes the segregation of the hardening δ' -phase and results in the maximum elastic limit. The maximum relaxation resistance and creep resistance was achieved for specimens quenched from 1100°C prior to their aging, since their structure then contains not only the gamma-solid solution and the high-disperse δ' -phase associated with it but also a small proportion of the lamellar η -phase. The structure of the EP557 alloy which, after quenching contains the insoluble η -phase, resembles the Widmanstaetten structure discovered in Ni-Ti, Ni-Ti-Al, Ni-Cr-Ti-Al, and Ni-Cr-Nb systems, except that it also displays some intermittent (cellular) decomposition of the solid solution. In industry the heat treatment of EP557 alloy strip should be based on quenching from 1080-1100°C in water and aging at 750°C for 4-6 hr. This assures sufficiently high fatigue strength and satisfactory performance of products manufactured from this alloy. Figures 7; references 8 (Russian).

USSR

UDC 669.018.45:620.172.22.05

INSTALLATION FOR MECHANICAL TESTING OF HEAT-RESISTANT ALLOYS UNDER CONDITIONS OF SUPERPLASTICITY

Moscow ZAVODSKAYA LABORATORIYA in Russian Vol 45 No 2, 1979 pp 166-169
manuscript received 19 Oct 77

SHARIF'YANOV, F. SH., CHERNYSH, V. V., Ufa Aviation Institute

[Abstract] The authors have developed an installation, based on a series-produced tensile-testing machine, which can perform a broad range of studies with extensive regulation and support of the constancy of the deformation rate at high temperatures, positional regulation and precise maintenance of the temperature, including a highly sensitive system for recording the forces of deformation. The installation consists of an electrotensometric force meter, a resistance furnace, and two clamps for application of tension, driven by a DC electric motor capable of developing up to 5,000 kgf of tensile force. The deformation rate can be varied from 0.1 to 1,000 mm/min. A schematic diagram of the thyristor electric drive regulator is presented. The temperature in the furnace can be maintained within 3°C between 900 and 1,300°C for 280-300 mm of the furnace length. Figures 3; references 3 (Russian).

USSR

UDC 539.385:669.721.5

INFLUENCE OF LOW TEMPERATURES ON THE FATIGUE FAILURE OF MA12 MAGNESIUM ALLOY

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian No 1, Jan/Feb 79
pp 21-25 manuscript received 27 Mar 78

GRINBERG, N. M., SERDYUK, V. A., OSTAPENKO, I. L., MALINKINA, T. I., KAMYSHKOV, A. S., Physico-Technical Institute of Low Temperatures, Academy of Sciences, Ukrainian SSR, Khar'kov

[Abstract] A study is presented of the influence of low temperatures on the fatigue characteristics of MA12 magnesium alloy as a function of its structural state. Cylindrical specimens 5.75 mm in diameter were prepared from heat-treated bars of the alloy. Their surfaces were then mechanically and electrically polished and fatigue testing was performed under a vacuum in symmetrical extension and compression at 25 Hz. The durability of the alloy was found to increase as temperatures decreased from 20°C to -120°C, particularly after annealing. The mechanism of both microscopic and macroscopic fatigue failure is brittle. It occurs by fracturing within grains in the low-amplitude area and by the formation of cracks between grains in the high-amplitude area, regardless of temperature. The only exception is the hardened alloy, for which cracks develop and grow primarily between grains at low temperatures with stresses less than 11 kgf/mm². Figures 1; references 7: 5 Russian, 2 Western.

USSR

UDC 621.780

ON THE POSSIBILITIES OF CALCULATING THE MECHANICAL PROPERTIES OF CASTINGS
MADE FROM COMMERCIAL AL-MG ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY SSSR, TSVETNAYA METAL-
LURGIYA in Russian No 1, 1978 pp 122-127 manuscript received 21 Nov 77

KORNUAKOV, A. S., BELOUSOV, N. N., ZOLOTOREVSKIY, V. S., and KASHEVNIK, L. YA.,
Moscow Institute of Steels and Alloys, Chair of the Metallurgical Study of
Light, Rare, and Radioactive Metals

[Abstract] Simple formulas were derived for Al alloys containing 6--11% Mg and varying amounts of the elements Mn, Cr, Ti, Be, Zr, Fe, and Si. The equation had the form $Y = b_0 + b_1 X^{-1/2}$ for the following relationships. Y = strength, X = average linear dimension of the dendritic cell; Y = strength, X = average size of the inclusions of excess beta-phase; Y = relative elongation, X = average size of the inclusions of excess beta-phase; Y = strength, X = average linear dimension of the grains in the hardened steel; and Y = relative elongation, X = average linear dimension of the grains in the hardened steel. The constants are calculated and the equations are given, together with the range in compositions evaluated and the least squares deviations. References 4 (Russian).

USSR

UDC 621.762

INVESTIGATION OF THE BRITTLE TO DUCTILE TRANSITION IN FIBROUS TUNGSTEN AND MOLYBDENUM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 79 pp 44-47 manuscript received 21 Aug 78

KARPINOS, D. M., RUTKOVSKIY, A. YE. and KONDRAT'YEV, YU. V., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] The problems of the ductile to brittle transition state of permeable porous materials made from tungsten- and molybdenum-base fibers are examined. Impact tests showed that the brittle-ductile transition temperature of these fibrous materials is 200-300°C lower than their corresponding compact metals: -190°C for fibrous molybdenum and 250-300°C for fibrous tungsten. This lowering of the transition temperature is caused by the degree of fiber deformation, the specific structure of the materials and the technological conditions of the process including fiber recrystallization. Thus these two fibrous materials, with their high heat resistance and lower embrittlement temperature, show promise as structural materials. Figures 3; references 5: 3 Russian, 2 Western.

USSR

UDC 621.762:669.018.95

EFFECT OF ZrO_2 ACICULAR CRYSTALS ON THE THERMAL STABILITY OF AN Al_2O_3+Mo CERMET

Kiev POROSHKOVAYA METALLURGIYA in Russian No 3, Mar 79 pp 55-59 manuscript received 30 Mar 78

KALINICHENKO, V. I., KARPINOS, D. M., MIKHASHCHUK, YE. P., KONDRAT'YEV, YU. V. and MOROZOV, YU. I., Institute of Problems of Material Science, Academy of Sciences UkrSSR

[Abstract] A composite made of 80% Al_2O_3 and 20% Mo was reinforced with acicular whisker crystals of ZrO_2 and produced by hot pressing. The resultant composite had a density of 5.56 g/cm³, melting point--2600°C, tensile strength--300 kgf/mm² and coefficient of thermal expansion (20-1000°C) --10⁻⁶ deg⁻¹·10. Thermal stability was studied by heating samples to 1200°C, soaking for 10 minutes and water quenching. Then the samples were air dried, recharged into the furnace and the cycle repeated until the samples suffered catastrophic failure. It was found that there was an optimum ZrO_2 content

which provided the highest thermal stability. This was 10% ZrO_2 as too few fibers don't give the reinforcement required and too many fibers introduces increased porosity resulting in reduced strength. At the optimum ZrO_2 content, samples could sustain 66-69 thermal cycles before failure. Figures 3; references 9: 8 Russian, 1 Western.

USSR

UDC 669.1'784.017.12

EFFECT OF ALUMINUM ON STEEL WITH 12% CHROMIUM AND A VARYING CONTENT OF MANGANESE

Minsk IZVESTIYA AKADEMII NAUK BSSR. SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, Apr 79 pp 44-47 manuscript submitted 25 Apr 77

SHVEDOV, L. I., Physico-Technical Institute, Academy of Sciences Belorussian SSR

[Abstract] Polythermal sections of the Fe-C-Cr-Mn-Al system were studied to find a means of increasing the heat resistance of this steel. All components were held constant except for Mn, which varied from 0 to 28.4% and Al, where the sections with 1.3 and 2.4% were studied. Carbon content was in the 0.35-0.40% range, and Cr--12.2%. For a 1.3% Al content, the effect of the Al as a ferrite-former was very small but when the content was raised to 2.4% the picture changed significantly. In general, depending on temperature (650-1150°C) and Mn content, magnetic permeability and hardness dropped with increasing Mn. This was due to the multiplicity of microstructures with the varying chemistry and temperature. No specific mention was made as to increased heat resistance of this steel. Figures 2; references 3 (Russian).

USSR

UDC 669.14.018.8

SMEETING A MARTENSITIC CORROSION-RESISTANT STEEL WITH A GIVEN PHASE COMPOSITION

Moscow STAL' in Russian No 3, Mar 79 pp 185-187

GRISHCHENKOV, P. M., KACHANOV, YE. B., STETSENKO, N. V., MOSHKEVICH, YE. I. and BUNINA, T. I.

[Abstract] The technology of producing EP410U martensitic stainless steel by vacuum-arc remelting has been mastered at the Dneprospetstal' Plant. This technology improved the level and stability of the mechanical properties of the steel by adding carbon (ferrochromium carbide) and nickel to achieve a given phase composition. This process lowers Mn and N, content which is compensated for by an increased Ni content, thus yielding a steel with higher tensile strength than could be achieved by electroslag remelting. Impact strength, however, dropped significantly. EI817 steel was produced by electroslag remelting using the same approach as above to achieve a given phase composition. In both cases the required level and stability of the desired mechanical properties was achieved. Figures 5; references 4 (Russian).

DEVELOPMENT AND INVESTIGATION OF THE TECHNOLOGY OF SMELTING CORROSION-RESISTANT STEEL IN A CONVERTER

Moscow STAL' in Russian No 3, Mar 79 pp 183-185

STOMAKHIN, A. YA., SEMIN, A. YE., GRIGORYAN, V. A., KOLGANOV, G. S., KOSTYANOV, B. M., SAVANIN, V. P., KORMILITSIN, S. P., KAPEL'NITSKIY, V. G. (Deceased) and TULIN, N. A., Moscow Institute of Steel and Alloys, Tulachermet Scientific Production Union, the Gipronikel' Institute, and the Ministry of Ferrous Metallurgy USSR

[Abstract] The technology of smelting corrosion-resistant steel using a side or top oxygen blow with additives of steam, argon, nitrogen or natural gas has been tested on an experimental unit at the Tulachermet Scientific Production Union. This technology makes it possible to modify any ferrous-metal converter for the production of steel; the experimental unit employed was based on a 10-ton converter. The converters at the Pobyzh Nickel Plant, which are not completely charged, have been slated for modification, and calculations indicate that, even though there will be a capital expenditure of 20 million rubles in the first stage of modification, there will be an additional profit of five million rubles per year. The main savings will come from increasing capacity, using heat from molten ferronickel, eliminating the need to pour into ingots, and more completely using alloying elements. Figures 2; references 6 (Russian).

PROCESSING HIGH STRENGTH STEEL FOR INCREASED PLASTICITY

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, 1979 pp 10-12

SAZONOV, V. G. and DROZDOVA, I. A., Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] The hardening of steel by thermomechanical treatment (TMT) usually enhances its proneness to brittle fracture, and this restricts the applications of TMT. However, the plasticity margin of steel in the high-strength state can be increased by pre-quenching and reheating to intercritical temperatures prior to TMT, since this leads to the formation of a disperse lamellar ferrite-austenite structure. This probably results also in the formation of a substructure since, according to the theory of structural

heredity the reheating of pre-quenched steel produces a substructure representing a somewhat inherited dislocation structure of quenched steel with superposition of lattice distortions arising during phase realignment. After its deformation, steel with disperse heterogeneous lamellar structure should display a distinct fibrous natural-composite structure which is inherited during final quenching and thus results in a high plasticity. These assumptions were tested on industrially melted 30KhGSA and 40KhS structural steels in the form of rods 8 and 5 mm in diameter and 450 mm in length subjected to various regimes of preliminary and final TMT. It was found that preliminary cold drawing of the rods of both steels, followed by their quenching from 950 and 980°C, respectively, enhances their strength and plasticity. A still greater increase in strength and plasticity is attained by subjecting the specimens to high-speed quenching and reheating to intercritical temperatures. X-ray structural analysis of the so treated specimens showed that the axial-deformation texture which arose in them after cold drawing persisted during subsequent phase recrystallization. Figures 2; references 7 (Russian).

USSR

UDC 669.187.26

SMELTING STEEL IN PLASMA ELECTRICAL FURNACES

Moscow STAL' in Russian No 2, 1979 pp 115-117

BORODACHEV, A. S., OKOROKOV, G. N., POZDEYEV, N. P., TULIN, N. A., FIEDLER, HANS, MUELLER, FRANZ, and SCHARF, GERHARDT, All-Union Scientific Research Institute for Electric Smelting, Central Scientific Research Institute for Ferrous Metallurgy, Institute for Ferrous Metallurgy, and the Ministry of Ferrous Metallurgy, USSR and GDR

[Abstract] After long collaboration in high temperature physics, scientists and technicians of the USSR and the GDR have developed constant arc plasma currents as a heat source for smelting steel. The plasma furnace developed can replace arc furnaces, and provides quiet, steady operation. The prototype, with a 30-ton capacity, was constructed at Freital in the GDR and installed in line in such a manner that it can be replaced for maintenance without interrupting steel smelting operations. Precise specifications and capacities are presented. The 30-ton model and a 10-ton model have demonstrated economic advantages in producing high quality steel alloys, and have application as well for less technical products. Figures 1; references 8: 3 Russian, 2 English, 3 German.

EFFECT OF CYCLIC TEMPERATURE AND STRESS CHANGES ON 15Kh1M1F STEEL HEAT RESISTANCE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 3, Mar 79
pp 626-630 manuscript received 7 Dec 77

NOVITSKAYA, G. M. and RYCHKOV, A. A., All-Union Thermo-Technical and Scientific Research Institute imeni F. E. Dzerzhinsky, Urals Affiliate

[Abstract] The effect of cyclic changes in temperature and stress on the long-time strength of 15Kh1M1F steel (0.16%C, 0.32%Si, 0.52%Mn, 1.17%Cr, 1.04%Mn, 0.26%V, 0.022%S and 0.016%P) was studied after normalizing at 1030° followed by tempering at 740° for 10 hours to produce a microstructure consisting of ferrite, 70% bainite and carbides. Testing was done by heating samples from 300 to 565° with a simultaneous increase in load, soaking at constant load for 5.5 hours, furnace cooling to 300° with load reduced to minimum and soaking at 300° for 30 minutes. Duration of one cycle was nine hours. The rate of temperature change during heating and cooling was 3 deg/min. Test results showed that cyclic changes in temperature and load lower the long-time strength of this steel. The increased creep rate is accompanied by loss of ductility due to an intensive development of grain-boundary damage, especially at stress concentrator points. Figures 4; references 4 (Russian).

USSR

SYNTHESIS AND INVESTIGATION OF THE PROPERTIES OF SUPERHARD MATERIALS

Kiev SINTETICHESKIYE ALMAZY in Russian No 2, Feb 78 pp 28-31

SHUL'MAN, L. A., Candidate of Physical and Mathematical Sciences

[Abstract] The following reports were heard at a section conference on the Synthesis and Investigation of the Properties of Superhard Materials, which was held in Kiev 7-9 December 1977:

Methods of Synthesis:

1. Problems of modernizing high-pressure equipment used for synthesis of superhard materials (A. I. PRIKHNY, ISM (Institute of Superhard Materials)).
2. Introduction and success in the use of synthetic diamonds and diamond tools at the Poltava Plant in strengthening hard alloys (M. S. PIVOVAROV, V. P. BARABIN and YU. V. ZHEREBTSOV, PZIIAI (Poltava Synthetic Diamond and Diamond Tool Plant) and M. G. LOSHAK and L. I. ALEKSANDROVA, ISM).
3. Study of the effect of container material on phase transformations in boron nitrile (V. B. SHIPILO, A. S. NICHIPOROVICH, N. N. SIROTA, M. M. ZHUK and N. M. OLEKHNovich, Institute of Solid State Physics and Semiconductors, Belorussian Academy of Sciences).
4. Epitaxial growth on diamond powders of transition diamond-graphite layers (V. N. BAKUL', YU. I. NIKITIN, O. P. BESPAL'KO, V. G. POLTORATSKIY, and G. C. POSTOLOVA, ISM).
5. Dynamic methods of synthesis (V. D. ANDREYEV, V. A. LUKASH, V. M. KUDINOV, V. G. PETUSHKOV, A. A. DERIBAS, A. M. STAYER, R. P. DIDYK and V. P. BILOKON' who represented ISM, Institute of Electric Welding imeni Ye. O. Paton, Dnepropetrovsk Mining Institute imeni Artem and the Institute of Hydrodynamics, Siberian Division Academy of Sciences USSR).

Physical-Chemical Foundations of Diamond Crystallization Processes:

1. Problems of diamond nucleatons (D. V. FEDOSEYEV, Corresponding Member, Academy of Sciences USSR, and B. V. DERYAGIN, S. P. VNUKOV, V. P. MENON, B. A. ANIKIN and I. G. VARSHAVSKAYA (Institute of Physical Chemistry, Academy of Sciences USSR).
2. Crystallization of diamond in metallic melts under pressure (A. K. BUTYLENKO, Institute of Metal Physics, Academy of Sciences UkrSSR).

3. Features of diamond crystallization process kinetics in the graphite-metal system (G. V. BOKIY, IGEM (Institute of Ore Deposit Geology, Petrography, Mineralogy and Geochemistry) and N. G. SANZHARLINSKIY and A. V. POMCHALOV, VNIISIMS [Expansion Unknown]).

4. Results of studying the rate of a direct graphite-diamond transformation and in the presence of dissolvent metals (Mn, Ni, Cr) under different thermodynamic conditions (G. N. BEZRUKOV, VNIIMALMAZ) [Expansion unknown].

Properties of Diamonds:

1. Impure formations in diamonds (YU. A. KLYUEV, A. M. NALETOV, V. I. NEPSHI and T. I. BULYGINA, VNIIMALMAZ).

2. Photoconductivity of synthetic semiconductor diamonds (A. S. VISHNEVSKIY and A. G. GONTAR', ISM).

3. Temperature function of microhardness in synthetic diamond (V. N. BAKUL', M. G. LOSHAK and V. I. MAL'NEV, ISM).

4. Investigation of the brightness of luminescence in synthetic alloyed diamonds (N. T. KLIMENKOVA, YU. M. ROTNER and YE. O. PROKOPCHUK, OGU (Odessa State University imeni I. Mechnikov)).

5. Results of investigating the external morphology and fine microstructure of synthetic diamond crystals alloyed with rare-earth elements (S. I. USPENSKAYA, Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov, G. N. BEZRUKOV, VNIIMALMAZ, and T. A. ZYUBINA, Voronezh Polytechnical Institute).

6. Microstresses and mechanical strength of superhard material structures (ZH. G. MALIKOVA and A. A. SEMERCHAN, IFVD (Institute of High-Pressure Physics)).

7. Thermomechanical characteristics of synthetic diamonds alloyed with nitrogen (N. F. KIROV, VNIIMALMAZ).

8. Results of investigating the wetting of diamond by alloys of transition metals (Ti-Ni, Ti-Co and Ti-Si) (A. V. NOZHKINA and V. I. KOSTIKOV, VNIIMALMAZ).

9. Study of synthetic diamond strength in relation to density (YE. F. DOLGOPOL'SKAYA, M. YA. KATS, N. F. KIROVA, L. YE. SHTERENBERG and I. G. YURCHENKO, representing the Geology Institute of the Academy of Sciences USSR, IFVD and VNIIMALMAZ).

Superhard Materials Made From Dense Modifications of Boron Nitride:

1. Ferroboron--a highly defective wurtzite nitride of boron produced by explosion (S. V. PERSHIN, G. A. ADADUROV, A. N. DREMIN, T. V. BABINA and O. N. BREUSOV, IKhF (Institute of Chemical Physics)).
2. Composite superhard material made from wurtzite boron nitride (G. KARYUK, IPM (Institute of Powder Metallurgy, Academy of Sciences UkrSSR)).
3. Data on phase and structural changes which occur in the contact areas of cutters made of Mexanite-P (L. S. PALATNIK, L. I. GLADKIKH, M. YA. FUKS, Z. I. KOLUPAYEVA and V. P. ZUBAR', KhPI (Khar'kov Polytechnical Institute imeni V. I. Lenin)).
4. Action of the sintering process on phase transformations in a wurtzite-like boron nitride (V. A. PESIN and L. I. FEL'DGUN, VNIIASH (All-Union Scientific Research Institute of Abrasives and Polishing)).
5. Results of studying the structure and properties of grade LP El'bor (L. I. FEL'DGUN, V. M. DAVIDENKO and YU. A. ALEKSEYEV, VNIIASH).

USSR

UDC 546.12-162

EPITAXIAL SYNTHESIS OF DIAMOND

Kiev SINTETICHESKIY ALMAZY in Russian No 2, Feb '79 pp 18-20

DERYAGIN, B. V. and FEDOSEYEV, D. V., Institute of Physical Chemistry, Academy of Sciences USSR

[Abstract] Epitaxial growth of diamond crystals from the gaseous phase is described. An equation formulated by O. I. Leypunskiy is presented which describes the equilibrium of the diamond and graphite phases when grown on a substrate. In the case of growing diamonds on a diamond surface, autoepitaxy occurs. Growth from the gas phase is explained by the formation of diamond nuclei from the gas phase. The carbon atoms promote the formation of chemical bonds with the different types of hybridization of electron orbits. Therefore the formation of a different type of crystal structure is possible in the synthesis of diamond. The prospects of using gas-phase crystallization have been linked with possibilities of modifying the surface of diamonds, metals and dielectrics, and with the creation and study of thin carbon layers. References 12: 11 Russian, 1 Western.

USSR

UDC 620.22

POLYCRYSTALLINE AND COMPOSITE SUPERHARD MATERIALS

Kiev SINTETICHESKIYE ALMAZY in Russian No 2, Feb 79 pp 16-18

BAKUL', V. N., Institute of Superhard Materials, Academy of Sciences UkrSSR

[Abstract] Slavutich, which is stronger than diamond but not as wear-resistant, is being used extensively in the USSR as the cutting material in the drilling of deep oil and gas wells. During the ninth five-year plan, slavutich-tipped drill bits have been used to drill a total of two million meters of deep wells. Each drill bit with slavutich cutters can be used to drill to 260-290 meters, which is equivalent to 25-30 conventional bits. The introduction of slavutich drill bits has produced an annual economic effect of 85 million rubles. It has also saved 212,600 conventional bits and 17,400 tons of high-alloy chromium-molybdenum steels.

USSR

UDC 621.921.3:661.65

CUBIC BORON NITRIDE-BASE TOOL MATERIALS

Kiev SINTETICHESKIYE ALMAZY in Russian No 2, Feb 79 pp 15-16

LYSANOV, V. S., All-Union Scientific Research Institute of Abrasives and Polishing

[Abstract] IFVD (Institute of High Pressure Physics) of the Academy of Sciences USSR, VNIASH (All-union Scientific Research Institute of Abrasives and Polishing) and IPM (Institute of Powder Metallurgy) of the Academy of Sciences UkrSSR are all working on developing boron nitride-base tool materials in order to relieve the situation of producing tungsten-base tools since tungsten is a scarce item. VNIASH has completed development of a new modification of a boron nitride-base tool material whose composition and production method makes it possible to produce four-carat low-pressure polycrystals. Tools made from these crystals can be used to machine steels (Rockwell C hardness up to 45) and cast iron. Using these tools has increased cutting speed by a factor of 4.5 and productivity by a factor of 2-3.

USSR

UDC 621.921.34:666.233

STATE AND BASIC PROBLEMS OF THE DEVELOPMENT OF NEW SYNTHETIC DIAMONDS AND DIAMOND TOOLS

Kiev SINTETICHESKIYE ALMAZY in Russian No 2, Feb 79 pp 11-15

ROMANOV, V. F., All-Union Scientific Research Institute of Diamonds

[Abstract] One of the most recent significant developments in the synthetic diamond field has been the development of technology for producing clad (two-layer) diamond plates consisting of a metallic or hard-alloy substrated with a diamond-base layer sintered on it. This was developed by the All-Union Scientific Research Institute of Diamonds (VNIIALMAZ) with individual variants of the process developed by the Institute of Physical Chemistry, Academy of Sciences USSR. The thickness of the plates can vary from 7 to 14 mm. They can be made in cylindrical, square or triangular form and their advantages lie in greater strength, and simplicity in sharpening and fastening to a holder. VNIIALMAZ is conducting work on developing the technology for sintering micropowders to produce a new material for diamond fibers. Using high-pressure chambers in 500- and 2000-ton presses they can produce ASO, ASR and ASV diamonds and, to some degree, ASK and SAM single crystals. VNIIALMAZ is also looking into an automatic process of diamond crystallization and coating of diamond grains with various materials. VNIIALMAZ and Moscow State University are developing binders with low-melting metallic fillers.

USSR

UDC 621.921.34:666.233

DEVELOPMENT OF RESEARCH INTO DEVELOPMENT AND APPLICATION OF SUPERHARD MATERIALS

Kiev SINTETICHESKIYE ALMAZY in Russian No 2, Feb 79 pp 8-11

NOVIKOV, N. V., Institute of Superhard Materials, Academy of Sciences UkrSSR

[Abstract] The efforts of various Soviet institutes in the field of superhard materials and diamond synthesis are described. The Institute of Superhard Materials (ISM), Institute of Electric Welding imeni Ye. O. Paton, Dnepropetrovsk Mining Institute and the Institute of Hydrodynamics, Siberian Branch, have jointly studied dynamic methods of superhard material synthesis including mastering dynamic synthesis of both cubic and hexagonal modification of diamond. Epitaxial growth of diamond crystals has been developed jointly by ISM and the Institute of Physical Chemistry. ISM and the Institute of Colloidal Chemistry and Chemistry of Water have studied adsorption activity, lyophilicity, electro-surface phenomena and the rheological properties of synthetic diamond powders. ISM and the Poltava Synthetic Diamond

and Diamond Tool Plant have investigated and developed a basis for mechanizing and automating a line for cleaning and classifying products of the synthesis of superhard materials. ISM has developed methods of applying metallic and other coatings on powders of synthetic diamonds and cubonite. ISM and the Experimental Scientific Research Institute of Metal Cutting Tools have prepared and published recommendations on selection of tools for diamond, cubonite and elbor working.

THE EFFECTS OF HIGH TEMPERATURE THERMOMECHANICAL ISOTHERMIC PROCESSING ON THE STRUCTURE AND MECHANICAL PROPERTIES OF STEEL

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 130-139 manuscript received 28 Apr 78

BERSHTEYN, M. L., VLADIMIRSKAYA, T. K., ZAYMOVSKIY, V. A., KAPUTKINA, L. M., MOROZOVA, T. I., PITSKHELARI, N. N. and SAMEDOV, O. V., Moscow

[Abstract] The steel 60S2 was selected for the tests since it does not undergo structural changes resulting from free ferrite. Standard production samples were annealed in steps at 930°C for 2 hours, 600°C for 1 hour, and 930°C for 1 hour, then furnace cooled. Samples were then heated for 20 minutes at 900°C, rolled at 30% compression at a speed of 0.5⁻¹/sec, placed in a lead bath for 30 min at 600, 650, and 700°C, and air cooled. The control samples received only isothermic processing. Pearlite colonies were measured by electron microscope, and carbide particles and intercarbide distances by photonegative images. Results indicated that the high temperature thermomechanical isothermic processing increased durability by about 10% and viscosity by 15-20%. With higher temperatures both test and control samples showed increasing sizes and homogenization of sub-colonies and carbide particles. Heat deformation of austenite was related to changing durability properties, showing an inverse correlation to the square root of sub-colony dimensions in the pearlite structure. Figures 4; references 13: 10 Russian, 3 English.

THERMOMECHANICAL AND MECHANOTHERMAL TREATMENT OF TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, 1979 pp 50-54

KHOREV, A. I., All-Union Scientific Research Institute of Aviation Materials

[Abstract] There exist various methods of thermomechanical treatment (TMT) with the object of improving the structure and mechanical properties of titanium alloys. The mechanisms of the attendant increase in strength are the phase hardening due to the differences in the unit volume of the individual phases, and the dispersion work hardening due to interphase boundaries, which is determined by the dispersity of decomposition and hence also by the extent of the boundaries. The effectiveness of the attendant work hardening depends on the chemical and phase composition of the alloys. For Ti alloys treated with the β -stabilizing elements Al, Mo, Cr, and Fe, e.g. TMT consisting in water quenching, cold deformation, and aging enhances strength

to 160-180 kg/mm². The effect of the TMT of titanium alloys is due to the formation of curvilinear, jagged, or blurred boundaries of primary β -grains, a marked comminution of intragranular structure, and a more disperse and uniform decomposition of metastable β -, α' - or α'' phases during aging. This last factor is of decisive importance. The most effective methods of treatment are those at which the increase in strength due to dispersion hardening predominates over the increase in strength due to phase hardening. During high-temperature TMT the deformation of α - and β -alloys should be conducted at the temperature of the β -region, and the deformation of ($\alpha + \beta$)-alloys, at the temperature of the ($\alpha + \beta$)-region. Figures 3; references 2 (Russian).

USSR

UDC 669.14.018.44:548.4:620.187

STRUCTURE CHANGE IN HEAT-RESISTANT TYPE EP742 NICKEL ALLOY DURING THERMO-MECHANICAL TREATMENT

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 3, Mar 79 pp 548-557 manuscript received 18 Feb 77

KLESHCHEV, A. S., KORNEYEVA, N. N., NOTKIN, A. B. and YURINA, O. M., All-Union Institute of Light Alloys, Moscow

[Abstract] Ingots of EP742 alloy of the Ni-Cr-Co-Mo-Nb-Ti-Al system were produced by open-induction melting followed by vacuum-arc remelting and then were swaged by 40% at 1100-1120°, homogenized at 1200° for 8 hours, furnace cooled to 950°, air cooled and then swaged at 1080-1120° by 30-50% to yield an alloy with 35% gamma'-strengthening phase. Forgings 650 mm in diameter were subjected to thermomechanical treatment by quenching from temperatures 30° below and 40° above the temperature of complete gamma-phase dissolution (1050°), soaking for four hours at this temperature, air cooling followed by aging at 850° for eight hours, air cooling and aging at 760° for 16 hours. Results of mechanical tests showed that thermomechanical treatment of this alloy, including plastic deformation in the (gamma+gamma')-region with subsequent quenching under conditions of partial recrystallization at 1050-1080°, leads to a significant increase in tensile, yield and long-time strengths with loss of ductility. Tensile and yield strengths increased by 15-20 kg/mm² while long-time strength increased by 3-5 kg/mm² for a 100-hour test at 750°. The polygonized structure obtained by this treatment provides the optimum combination of properties if the structure contains 9-14% primary gamma-phase measuring 0.3-0.5 microns. Z. S. TRUKHANOVA, L. L. MESHKOV and A. S. FAYNBRON participated in this work. Figures 4; references 12: 5 Russian, 7 Western.

USSR

UDC 535.211

LASER HEATING OF THIN FILMS ON ABSORBING SUBSTRATES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 79 pp 14-17 manuscript received 27 Nov 77

BAYAZITOV, R. M., KHAYBULLIN, I. B. and ZARIPOV, M. M., Kazan'

[Abstract] Theoretical analysis of the processes of radiative heating of thin films is normally performed on assuming ideality of thermal contact with the substrate, and on assuming that the substrate is transmissive to radiation. If, however, the substrate is semitransmissive, absorption in the substrate can markedly affect film heating. In this connection the solution of the problem of the heating of thin films with allowance for heat sources conditioned by the absorption of the luminous flux both in the film and in the substrate is explored. The boundary-value problem of heat conduction is examined for a thin film on a semi-infinite substrate with allowance for the absorptance of both the film and the substrate. The obtained solution is analyzed and estimates of film temperature are derived for various extreme cases of substrate absorption (film-dielectric, film-semiconductor, film-metal). For the weakly absorbing substrate represented by the dielectric the solution is adjusted to a form corresponding to purely surfacial heating of the film by the fraction of luminous flux absorbed in the film. For the absorbing substrate represented by the semiconductor, allowance must be made for substrate absorption and the general formula derived should be used to compute the temperature of laser heating. For metals, depending on the absorptance and transmittance of the film, the heating of the system is chiefly determined by the absorption of emission in the metal substrate. Figures 1; references 6: 5 Russian, 1 Western.

USSR

UDC 535.211:539.216.2

CERTAIN ASPECTS OF THE DESTRUCTION OF THIN METAL FILMS BY POWERFUL LIGHT PULSES

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 79 p 33-36 manuscript received 11 Dec 77

VEYKO, V. P. and YAKOVLEV, YE. B., Leningrad

[Abstract] Attention is drawn here to certain previously uninvestigated features of the threshold mechanisms of destruction of thin metal films (TMF) by laser heating, uncovered through experimental investigation of the dependence of the destruction threshold of chromium TMF on their thickness during laser heating from the free TMF surface as well as through the transmissive substrate. The chromium TMF used in the experiments were obtained

by means of vacuum deposition on cold glass substrates ($T = 20^{\circ}\text{C}$), and their thickness values were 500, 1000, 1500, 2000, and 3000 Å. The dependence of the destruction threshold of TMF on their thickness is tentatively attributed to the existence of a critical thickness of the thermodynamic stability of the liquid thin film on the substrate (on heating from the free film surface side) as well as to the nonlinear thickness dependence of the temperature of the heated film surface and to an explosive mechanism of destruction (when heating from the transmissive-substrate side). The proposed threshold mechanism of TMF destruction consists in the evaporation of TMF to the instability thickness of the liquid film and in its subsequent concavity owing to surface tension. The fact that the destruction threshold of TMF on heating from the transmissive-substrate side is independent of film thickness is attributed to the constancy of the time of the heating of the film-substrate interface to the temperature of destruction. Figures 2; references 6 (Russian).

USSR

UDC 669.295'71'296'27:548.7

AN INVESTIGATION OF THE PHASE STRUCTURE AND PROPERTIES OF TITANIUM ALLOYS
CONTAINING ALUMINUM, ZIRCONIUM, AND TUNGSTEN

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 209-
210 manuscript received 11 Jan 78

GRIGOR'YEV, I. P. and NARTOVA, T. T., Moscow

[Abstract] The effects of supplemental alloying of a Ti-Al-W alloy by using zirconium are described in two variants, one with a constant 3% zirconium content and the other with 3% Al, 3% Zr, and varying quantities of tungsten up to 20%. The alloys obtained were annealed in vacuum quartz ampules as follows: at 1100°C for 50 hours, 1000°C for 100 hours, 900°C for 200 hours, 800°C for 300 hours, and 600°C for 500 hours. Results indicated that tungsten had markedly less effect on the temperatures of solid phase reactions than did aluminum. The beneficial effect of tungsten on the durability of alpha-titanium was retained in triple and quadruple structural systems in the studied compositions. Figures 2; references 4 (Russian).

USSR

UDC 669.6:669.296:669.295

DISTRIBUTION OF TIN AND ZIRCONIUM BETWEEN THE PHASES IN α + β -TITANIUM
ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3,
1979 pp 54-56

GUS'KOVA, YE. I., LASHKO, N. F., SOLONINA, O. P. and YERMOLOVA, M. I.

[Abstract] The elements with which Ti alloys are treated are divided into α -, β -stabilizers and neutral elements (zirconium, hafnium, tin). But depending on the temperature the neutral elements may also become α - and β -stabilizers in binary alloys. In this connection, five Ti-Al-Mo-Cr-Fe alloys treated with 0, 0.5, 1, 1.5, and 2% Sn and in one case also with 1.6% Zr were investigated. Their β -phases were electrochemically isolated and subjected to chemical and x-ray structural analyses. The composition of the five alloys was as follows: alloys 1, 2, 3, 4 contained ~6% Al, 2.3% Mo, 1.4% Cr, 0.3% Fe and 0, 0.5, 1, and 1.5% Sn, respectively. Alloy 5 contained 6.7% Al, 2.4% Mo, 0.5% Cr, 0.2% Fe, and ~2% Sn and 1.6% Zr. After rolling into 20-mm-diameter rods, annealing at 870°C for 1 hr + 650°C for 2 hr and cooling in air, the notched specimens were subjected to longterm aging at 400-550°C for 100 to 20,000 hr. In the process of such aging the β -phase is enriched with β -stabilizers (Mo, Cr, and Fe). The Sn content of the β -phase also increases.

Hence, Sn is redistributed between the α - and β -phases and behaves as a β -stabilizer. The enrichment of the β -phase with Sn occurs more slowly than enrichment with Mo, Cr, and Fe, which is probably due to the greater size of Sn atoms. The concentration of Zr in the β -phase, on the other hand, equals its concentration in the alloy and is virtually independent of the temperature and duration of aging. Hence, in the alloys investigated, Sn acts as a β -stabilizer while Zr is a neutral element. Longterm aging of the alloys at 400-550°C enhances their strength and reduces their plasticity. Figures 1; references 6 (Russian).

USSR

UDC 66.014:620.18:669.295

EFFECT OF CHEMICAL COMPOSITION ON THE FORMATION OF MARTENSITE IN TITANIUM ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, 1979 pp 16-17

LOKSHIN, F. L. [deceased], All-Union Institute of Light Alloys

[Abstract] Alpha" martensite forms in binary alloys of titanium with V, Nb, Ta, Mo, W, and Re, while in the Ti alloys with Cr, Mn, Fe, Co, Al, and others this phase is absent. Considering that J. Williams et al (Met. Trans., No 2, p 477, 1971) and C. Luke et al (J. Nucl. Mater., Vol 16 No 1, p 7, 1965) account for the formation of metastable phases during the quenching of zirconium alloys by referring to Brillouin's theory of zones, it was of interest to verify the applicability of that theory to the formation of α'' -martensite. To this end, the change in phase composition as a function of Zr content was investigated in alloys of the system Ti-Cr-Zr that were quenched from 900°C (β -phase). This alloy system was selected because α'' -martensite does not form in binary Ti-Cr and Ti-Zr alloys. According to a hypothesis, Ti-Cr alloys do not assure the needed magnitude of atomic volume while Ti-Zr alloys do not provide the needed electron concentration. Hence it can be expected that in a Ti-Cr-Zr system the chromium will assure the needed electron concentration and the zirconium, the needed atomic volume. X-ray structural analysis showed that in alloys of the Ti-Cr-Zr system containing 2 at.% Cr the electron concentration $n_e = 4.04$ e/a. Increasing the Zr content from 0 to 4 at.% increases the atomic volume from 17.51 to 17.72 Å³. Regardless of the atomic volume, α'' -martensite does not form when the electron concentration is 4.04 e/a in Ti-Cr-Zr and Ti-Cr alloys. When $n_e = 4.06-4.08$ e/a, α'' -martensite forms only in the alloys with the atomic volume of from 17.55 to 17.63 Å³. In alloys with a lower atomic volume the martensite does not form. As the Cr content increases, there is a decrease in the content of the Zr needed for the formation of α'' -martensite. References 6: 3 Russian, 3 Western.

DISTRIBUTION OF IRON AND ALUMINUM IN TITANIUM ALLOYS

Moscow METALLOVEPENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, 1979 pp 56-58

SHAPOVALOVA, O. M. and ONISHCHENKO, T. N., Dnepropetrovsk State University

[Abstract] Al and Fe, which are present in most Ti alloys, are the most potent α - and β -stabilizers. In this connection the distribution of Al (3-5%) and Fe (0.15-1.5%) in five different Ti alloys was investigated on forged and annealed specimens with the aid of a Cameca x-ray micrographic and spectral analyzer and a DRON-0.5 diffractometer. The curves of intensity distribution plotted for iron and titanium K_{α} -radiation showed that the distribution of iron in binary titanium alloys in cast and annealed states is--by contrast with the quenched state--extremely nonuniform. A corresponding investigation of ternary alloys containing both iron--a strong β -stabilizer--and aluminum--an α -stabilizer--showed that Al is also nonuniformly distributed, though not to such a large extent. The Fe concentration peaks in β -phase interlayers correspond to minima of Al content, and vice versa. This points to a definite pattern of the distribution of α - and β -stabilizers, with the former being located in the α -lamellae and the latter, in the interlayers between these lamellae, within which the metastable β -phase persists. Consequently, α - and β -stabilizers are mutually exclusive in location. Thus, the Fe in Ti alloys with 0.15-1.5% Fe chiefly concentrates in the metastable β -phase of varying composition. Further, as the Al content increases from 3 to 5%, the nonuniformity of Fe distribution increases by a factor of 2. Figures 1; references 2 (Russian).

DEVELOPMENT OF RESEARCH INTO THE THERMOKINETICS OF STRUCTURAL AND PHASE TRANSFORMATIONS IN METALS AND ALLOYS

Minsk IZVESTIYA AKADEMII NAUK BSSR. SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, Apr 79 pp 34-43 manuscript received 30 Jul 78

BODYAKO, M. N., Physico-Technical Institute, Academy of Sciences Belorussian SSR

[Abstract] A description is given of the development of the thermal treatment of alloys, mainly by high-speed electric heating, in the Belorussian SSR. In 1956 the Physico-Technical Institute started research in a field of physical metallurgy--thermal kinetics of structure and phase transformations in metals and alloys under conditions of high heating rates. During 1966-75 the Institute conducted theoretical and experimental studies on the effect

of heating rate on phase and structure transformations and physical-mechanical properties in high-strength maraging and austenitic stainless steels, high-strength titanium alloys, corrosion-resistant, electrotechnical and magnetic alloys, and transformer and sheet steels. These efforts resulted in formulation of thermokinetic theories for multiphase alloy transformations. VT16 and VT30 titanium alloys were specifically studied, where it was found that during rapid heating the beta-stabilizing elements are redistributed by diffusion, which suppresses catastrophic beta-grain growth to produce a stronger martensite in VT16 and a more ductile beta-phase in VT30.

USSR

UDC 621.620.1:539.494

LONG-TIME STRENGTH OF SINTERED TITANIUM ALLOYS

Kiev PORUSHKOVAYA METALLURGIYA in Russian No 3, Mar 79 pp 67-70 manuscript received 12 Jul 78

ANTSIFEROV, V. N., SHVETSOV, A. V. and KRAVTSOVA, L. D., Perm Polytechnical Institute

[Abstract] Powders of Ti+4% Al were pressed, vacuum sintered at 1300°C and soaked at this temperature for four hours. Samples from the sintered blanks were cut and used to determine an approximate relationship of longevity of the alloy to the magnitude of the variable and constantly acting stress at a given temperature, porosity and sintering conditions as well as to predict the long-time strength for pulsing and gradually changing loads. Using the criteria of Bailey, A. A. Il'yushin and V. V. Moskvitin in differential form for long-time strength determination, it was found that for the 18 samples tested the criteria of Il'yushin was closer to unity than the other criteria. Il'yushin's divergence amounted on the average to 11.0% while the divergences of Bailey and Moskvitin were 25.0 and 21.4%, respectively. Figures 2; references 2 (Russian).

STUDY OF THE DECOMPOSITION OF THE BETA-PHASE DURING THE CONTINUOUS HEATING OF THE ALLOY VT16

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY SSSR, TSVEINAYA METALLURGIYA in Russian No 1, 1978 pp 103-109 manuscript received 24 Nov 77

MAL'TSEV, M. V., KASHNIKOV, N. I. and SOKOLOV, L. D., Gor'kiy Polytechnic Institute, Chair for the Thermal and Plastic Treatment of Metals

[Abstract] A new explanation is presented for the volume effects observed during the decomposition of the beta-phase during the continuous heating of VT16 alloy title process in the temperature range 200-500°C. The initial contraction in the temperature range 200-350°C is due to the homogeneous enrichment of beta stabilizers in the beta phase. Over the temperature range of approximately 350-500°C, the sample expands. Beginning at 350°C, areas begin to develop in the beta phase which are composed of particles containing either greater or lesser amounts of the beta stabilizer than the beta phase. As the temperature is increased toward 500°C, the number and size of such areas also increase. Above 500°C, the change $\Delta L/L$ is linear with temperature. Thus, the formation of beta phase regions leads to a contraction of the sample and conversely, that of the α phase, to an expansion. References 11: 7 Russian, 4 Western.

USSR

UDC 620.17:669.71:62-416

EFFECT OF ALLOYING ON THE STRENGTH PROPERTIES AND WELDABILITY OF ALUMINUM FOIL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, 1979 pp 43-44

DRITS, M. YE., KADANER, E. S., TOROPOVA, L. S., KHUDYAKOV, K. I. and DOL'NIKOV, S. S.

[Abstract] Foil of pure and commercially pure aluminum displays inadequate strength, and welded joints of that foil with gold film are prone to the formation of brittle intermetallic compounds. In this connection the effect of such alloying elements as Si, Mn, Y, Ce, and Sc on the mechanical properties and weldability of aluminum foil was investigated. The alloys were melted in an electric furnace with a removable crucible. The ingots were cast into a water-cooled mold at 700-720°C, homogenized, rolled at 500°C and subsequently at room temperature. Final rolling of the foil was accomplished after annealing at 400°C for 4 hr, on a 360/110 four-high mill. Foil 20-25 μm thick was investigated. Mechanical properties were determined on specimens cut out with a razor and tested on an Instron 500 machine at a deformation rate of 2 mm/min. The strength of ultrasonically welded joints of the foil with films of gold or aluminum was determined according to the tearing force of leaves of foil at right angles to the welding plane. In every case even minute additions of an alloying element resulted in a marked increase in the tensile strength. The maximum increase in strength was achieved on treatment with 1.4-1.6% Mn; ~0.4% Si and ~0.4% Sc. The tensile strength of the Al-1.6% Mn alloy is 24 kg/mm²; of the Al-0.38% Sc alloy, 18.5 kg/mm²; and of the Al-0.44% Si alloy, 19 kg/mm². Annealing at 300°C results in a marked (2.7-fold) decrease in the strength of Al-Si alloy foil, and a less marked decrease (1.6-1.7-fold) in the strength of foil of the alloys of the other systems investigated. Analysis of the stability of properties of welded joints of Al-alloy foil and gold film after annealing at 300°C for 10 hrs showed that the most stable tensile strength was displayed by joints of Al-Sc alloys. Figures 1.

USSR

UDC 669.3'71'295'296:620.181

PRECIPITATION MORPHOLOGY AND PRECIPITATION HARDENING IN INTERNALLY OXIDIZED ALLOYS OF THE COPPER-ALUMINUM-TITANIUM-ZIRCONIUM SYSTEM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 47 No 3, Mar 79 pp 595-604 manuscript received 18 Jan 78

DANELIYA, YE. P., TEPLITSKIY, M. D. and SOLOPOV, V. I., Giprotsvetmetobrabotka (State Scientific-Research and Design Institute of Alloys and the Treatment of Nonferrous Metals), Moscow

[Abstract] The internal oxidation of copper-base binary, ternary and quaternary alloys is discussed. In a Cu-0.22% Zr alloy, dispersed particles of ZrO_2 formed in the grain body during internal oxidation. In all cases of the twelve alloys studied, each alloy formed oxides for each alloying element but no copper oxide was formed. The oxides formed for the individual alloying elements were $\gamma-Al_2O_3$, ZrO_2 and TiO_2 with the average dispersed particle size ranging from 50 to 500 angstroms. In summary it is stated that in both binary and complex alloys the dispersity of particles is diminished the farther they are from the sample surface. As a result the average size of the oxides grows with increased thickness of a plate being subjected to internal oxidation. Therefore the yield strength for all of these alloys is higher than for thin samples. Micro-x-ray analysis was conducted by P. A. PINCHUK and L. A. AGAFONOVA. Figures 4; references 17: 8 Russian, 9 Western.

USSR

UDC 621.787.4:669.245:669.14.018.44

INVESTIGATION OF OPTIMAL METHOD FOR THE AREAL COLD DEFORMATION OF VT9 AND EI698VD ALLOY COMPRESSOR DISKS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 4, 1979 pp 13-16

BEYTLIN, V. I., POLOSKIN, YU. V., MAKAROVSKIY, N. L. and VOLKOV, V. I.

[Abstract] Areal plastic deformation (APD) (work hardening) is used to restore and enhance the fatigue strength of components of gas-turbine engines operating at normal and high temperatures. The optimal method of such work hardening of compressor disks of VT9 titanium alloy and EI698VD chromium-nickel alloy operating at 200-450 and 650°C, respectively, was explored. To this end, the disks were subjected to various modes of hydraulic and pneumatic shot-peening with steel micropellets followed by vibration hardening and vibration grinding. The optimal APD of VT9 alloy compressor disks was found to consist in pneumatic shot-peening followed by vibration grinding and hardening with micropellets. The disks so treated displayed residual compressive stresses of not more than 40-60 kg/mm² at the surface, owing to

the attendant work hardening which, an x-ray analysis showed, apparently results in an increase in the density of the surface-layer dislocations resistant to high temperatures. This was confirmed by fatigue tests of the specimens. For EI698VD (KhN73MBTYu) alloys the optimal APD method consists in treatment with micropellets assuring the formation of residual compressive stresses reaching not more than 120 kg/mm^2 at the surface. The broadening of x-ray lines was $300 \pm 20\%$ and the surface roughness $R_a = 1.25-0.63$. Figures 6; references 5 (Russian).

USSR

UDC 669.2

ON THE QUESTION OF REDUCING THE CHEMICAL LOSS OF ALKALIS AND ALUMINUM OXIDES DURING THE PREPARATION OF ALUMINA BY THE BAYER PROCESS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY SSSR, TSVETNAYA METALLURGIYA in Russian No 1, 1978 pp 40-44 manuscript received 21 Nov 77

NOVOZHENOV, V. M., TATAUROVA, T. I. and KUZNETSOV, S. I., Ukrainian Polytechnic Institute

[Abstract] Alkalies and aluminum oxide are lost due to the formation of sodium hydroaluminum silicates having the following composition: $\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3(1.65 - 1.8)\text{SiO}_2 \cdot n\text{H}_2\text{O}$. Adding lime to the bauxite in quantities sufficient to tie up the silicon as $3\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{SiO}_2 \cdot 4\text{H}_2\text{O}$ and titanium dioxide as $\text{CaO} \cdot \text{TiO}_2$ results in a reduction of the loss of alkalies in the slag from 2.2 to .4%. Subsequent treatment of the slag containing the aluminum oxides and silicon in the form of "hydrogranite" with a carbonate solution containing at least 80 g/l Na_2CO_3 permits the recovery of the excess aluminum oxides lost due to the liming. About 90% of the aluminum oxides in the slag is recoverable. The amount of soda necessary for processing the slag must be at least the stoichiometric amount required for the calcium hydroaluminosilicate salt. References 11: 10 Russian, 1 Western.

USSR

UDC 669.017:536.421

METASTABLE PHASES IN ALUMINUM MELTS CONTAINING CHROMIUM, VANADIUM, AND COBALT

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY SSSR, TSVETNAYA METALLURGIYA in Russian No 1, 1978 pp 99-102 manuscript received 28 Nov 77

GORICHOK, B. O., VENGRENOVICH, R. D., Chernovitsy State University, Chair of Solid State Physics

[Abstract] Experimental results are given for a study of the non-equilibrium crystallization of melts in the Al-Cr, Al-V and Al-Co systems in the stoichiometric and intermediate range of compositions. These metastable phases which form on the rapid quenching of the melts are apparently defect structures similar to the corresponding high temperature structures of the studied systems. Thermograms, microhardness, and lattice spacing determinations were used to document the presence and characteristics of the new phases. The Al-Cr system crystallized to a composition $AlCr_4$, the structure of which was different from the epsilon phase of the same composition which forms from melts having a higher Cr content. The Al-V system crystallized as a solid containing from 10 to 38.6 wt% V. The Al-Co system crystallized as a gamma-phase $Al_{13}Co_4$. References 11: 8 Russian, 3 Western.

USSR

UDC 536.422.1

DEVELOPMENT OF A THERMAL MODEL OF SURFACE VAPORIZATION OF METALS UNDER THE ACTION OF CONCENTRATED ENERGY SOURCES (A SURVEY)

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 79 pp 12-26 manuscript received 2 Dec 77

LYUBOV, B. YA. and SOBOL', E. N., Moscow

[Abstract] An examination is made of the results of theoretical studies of the process of metal vaporization that have been done in recent years in connection with the development of concentrated energy sources. The main ideas of the thermal model of vaporization are analyzed. A detailed examination is made of processes of unsteady vaporization, crater formation and vaporization of thin films. It is shown that when the laser pulse duration is 10^{-7} - 10^{-8} s, the model of gradual surface vaporization gives a good description of the process of film destruction by optical radiation in a certain range of film thicknesses that depends on the emission parameters and properties of the material. Outside of this thickness range, and also at

pulse durations of 10^{-3} - 10^{-4} s vaporization plays an essential part only at the beginning of the process of destruction. Although there has been a great deal of theoretical analysis of the process of vaporization in the quasi-steady and unsteady approximations, the quantitative discrepancy between theoretical and experimental results may be quite considerable. This can be attributed to inadequate precision of models without consideration of all the factors that exist in real situations, the approximate nature of solution of the corresponding problems and inaccuracy in the determination of the quantities that appear in the resultant formulas. Therefore further development of the thermal model of surface vaporization must take into consideration more and more different factors (solution of the unsteady three-dimensional problem, consideration of space and time inhomogeneity in the distribution of radiation, development of a quantitative theory of shielding of radiation by products of destruction), and also an increase in the accuracy of calculations. Thus it will be necessary to develop techniques for solving problems of heat conduction with moving boundaries and with more precise determination of the characteristics of materials that appear in the formulas. References 115: 93 Russian, 22 Western.

USSR

UDC 535.211

MEASURING THE SURFACE TEMPERATURE OF METALS IN THE PROCESS OF HEATING BY LASER EMISSION

Moscow FIZIKA I TEKHNIKA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 79
pp 27-30 manuscript received 10 May 77

DLUGUNOVICH, V. A., Minsk

[Abstract] A study is done on the change in surface temperature of aluminum, tungsten and stainless steel foil in the process of heating and destruction in air by focused radiation of a cw CO_2 laser with power of 200 W. The temperature was measured by the ISM-4M four-channel spectrometer designed and made by the Institute of Physics of the Belorussian Academy of Sciences. This instrument is designed for simultaneous measurement of emission intensity on wavelengths of 0.96, 1.19, 1.53 and 2.31 μm , enabling determination of both brightness and color temperatures. The spectral coefficients of surface blackness for the given materials were also determined as a function of the flux density of laser exposure. The results are interpreted in terms of the thermophysical properties of the materials and their oxides. It was found that the temperature at which aluminum and stainless steel are destroyed by CO_2 laser emission in air coincides with the melting point of their oxides. The temperature of tungsten destruction coincides

with the boiling point of WO_3 . In this case, a state of equilibrium is reached in the zone of laser action between the rate of vaporization of tungsten oxide and the rate of oxide formation on the metal-oxide interface, so that the thickness of the oxide film remains constant. The author thanks V. D. SHIMANOVICH and A. K. SHIPAY for making the ISM-4M spectrometer available for measurements, and also V. N. SNOPOKO for discussing the results. Figures 2; references 10: 9 Russian, 1 Western.

USSR

UDC 535.211

INVESTIGATION OF THE REFLECTION OF LASER EMISSION IN DESTRUCTIVE ACTION ON OPAQUE DIELECTRICS

Moscow FIZIKA I TEKHNIKA OBRABOTKI MATERIALOV in Russian No 1, Jan/Feb 79 pp 21-36 manuscript received 6 Mar 78

MIN'KO, L. YA., GONCHAROV, V. K. and LOPAREV, A. N., Moscow

[Abstract] The reflectivity of opaque dielectrics was studied in the experimental setup shown in the diagram. Emission from a neodymium laser (1000 J) was focused by lens 4 on the surface of target 1 with a diameter of 30 mm. The target was placed in the center of integrating sphere 12 with a diameter of 400 mm. The reflected emission was incident on photocell 6 and was registered on the screen of oscilloscope 8. Interference filter 9 was used to cut off plasma flare emission. Part of the incident emission was diverted by beam splitters 2 and 3 to calorimeter 5 and photocell 7, from which a signal was sent to the second channel of oscilloscope 8. The experiments provided data on reflection of laser emission on a wavelength of 1.06 μm from hard rubber, glass Textolite and Teflon with time resolution depending on flux density in the range of 10^4 - $4 \cdot 10^7$ W/cm^2 . It is found that the plasma jet containing products of destruction in the form of solid particles has a considerable influence on the reflection of incident laser radiation. These particles scatter the incident laser emission, causing nonlinear energy dependence of the coefficients of reflection of hard rubber and glass Textolite. Losses to reflection and scattering for these materials reach a maximum at a flux density of the order of 10^6 W/cm^2 , amounting to 50% in the case of hard rubber. Figures 3; references 7: 6 Russian, 1 Western.

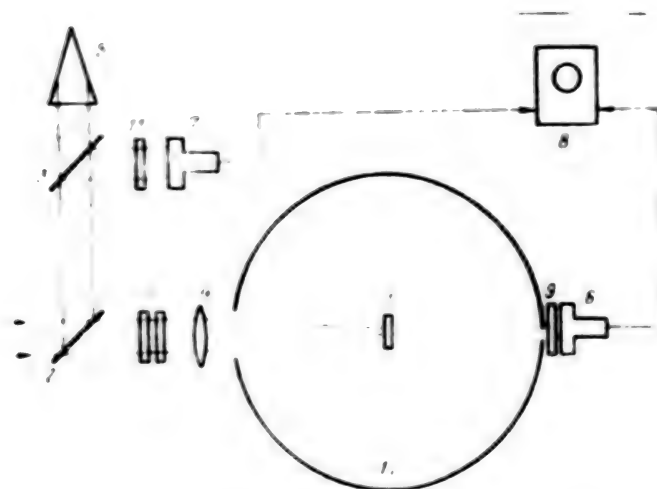


Рис. 1. Схема непрерывного ступенчатого противоточного процесса.

1 - ванна; 2, 3 - подающие устройства; 4 - распределитель; 5 - приемник; 6, 7 - фотоэлементы; 8 - контроллер; 9 - датчик; 10 - мешалка; 11 - распределитель; 12 - фотоэлементы.

USSR

UDC 669.18:66.06

INVESTIGATION OF CONTINUOUS STEP-COUNTERCURRENT REFINING OF METAL WITH A SLAG

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. CHERNAYA METALLURGIYA in Russian No 2, Feb 79 pp 35-39 manuscript received 13 May 77

BICEYEV, A. M., GORBATOV, V. N., CHERNOV, V. P., ALEKSANDROV, G. S. and VDOVIN, K. N., Magnitogorsk Mining-Metallurgy Institute

[Abstract] The basic modes of refining a metal with slag are examined: volume, full countercurrent of metal vs slag and step-countercurrent refining. Mathematical models are developed for these modes and a diagram is presented for "cold" modeling using the step-countercurrent mode of refining. This mode uses a three-step approach and a description is given of the process. Results of tests agree well with theoretical calculations and confirm the high effectiveness of two-step and especially three-step refining in comparison with a single-step process of complete mixing. Figures 3.

NEW METHOD OF DETERMINING THE VELOCITY COMPONENTS OF MOVEMENT IN THE ROLLING OF COMPLEX MOLDED SHAPES. Report 2

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. CHERNAYA METALLURGIYA in Russian No 2, Feb 79 pp 56-59 manuscript received 6 Jun 78

PISARENKO, F. A., YAKOVCHENKO, A. V. and LITVINENKO, A. YU., Donetsk Scientific-Research Institute of Ferrous Metallurgy

[Abstract] A new method of describing the surfaces of a deformation site by a single analytic function is presented in general form and the field of movement velocities determined using four-dimensional space, x, y, z, ct , which makes it possible to investigate the steady- and unsteady-state processes of rolling. The length of the deformation site along the width of the shape can be examined as the variable magnitude. The proposed method of determining the field of displacement velocities is general and can be used for determining the stress-strain state of a metal during the rolling of shapes of any configuration and can be easily accomplished on a computer. Figures 3; references 2 (Russian).

EFFECT OF THE METHOD OF PRESSURE TREATING ON THE DEFORMABILITY OF HIGH-TEMPERATURE ALLOYS

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY. CHERNAYA METALLURGIYA in Russian No 2, Feb 79 pp 51-55 manuscript received 5 Apr 78

VIEIDOROV, B. A., Magnitogorsk Mining-Metallurgy Institute

[Abstract] Research has been conducted in the rolling production laboratory of the Magnitogorsk Mining-Metallurgy Institute on replacing the drawing of wire by the ordinary method by the method of rolling in stands with multi-roll gages. KhN56VMTYuR and KhN67VMTYu high-temperature alloys were used to produce wire in monolithic fibers by the above mentioned method.

Prior to the drawing operation the wire rod was heat treated by heating to 1200°C, soaking for 20-30 minutes and air cooling. Using the above-described method it was possible to produce wire with a diameter of 3.6 mm with a high-quality surface without the intermediate operations of heat treatment and surface preparation. When wire is drawn in the conventional way, using the two alloys mentioned, the intermediate heat treatment is required and the resulting product usually has surface and internal defects in the form of longitudinal and lateral cracks, tears and flakes. Figures 6; references 2: 1 Russian, 1 Western.

ON THE MECHANISM OF RECRYSTALLIZATION DURING LASER TREATMENT

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 3, 1979 pp 17-19

YERSHOVA, L. S., Vladimir Polytechnic Institute

[Abstract] Laser treatment causes metal to get heated at extremely rapid rates. In this connection, it was of interest to investigate structural changes due to laser irradiation in alloys with and without polymorphic transformations. To this end phase transformations were investigated in 20N24 nickel steel (0.24% C, 24.13% Ni, remainder Fe; martensite start point $M_{sp} = -60^{\circ}\text{C}$) and, for comparison, in V16 tungsten steel (0.07% C, 16.85% W, 0.016% P, 0.048% S, remainder Fe), which does not undergo polymorphic transformation. Forged and annealed specimens of both steels were subjected to metallographic and electromicroscopic analysis, upon being subjected to pulsed irradiation in a laser installation with a total radiation energy of ~ 1 J and pulse duration of ~ 1 msec. Microstructure was investigated in the specimen areas located below the cratering produced by the laser beam. In V16 steel, in which polymorphic transformations are absent, laser irradiation did not change the grain size of the solid solution in the zone of thermal influence. In 20N24 steel, on the other hand, which undergoes $\alpha \rightarrow \beta$ transformation, laser irradiation resulted in recrystallization with the formation of superfine austenite grain. The recrystallization in the steel with martensitic structure is due to the attendant realignment of substructure and the formation of wide-angle boundaries. The observed mechanism of recrystallization is clearly due to the high density of crystal-structure defects in the original martensitic structure of the steel. References 6 (Russian).

BREAKDOWN OF CRYSTALLIZED LAMELLAR EUTECTIC Ni_3Al - Ni_3Nb ALLOY UNDER DYNAMIC BENDING

Minsk IZVESTIYA AKADEMII NAUK BSSR, SERIYA FIZIKO-TEKHNICHESKIKH NAUK in Russian No 4, 1978 pp 52-56

NESTEROVICH, L. N., GAZOV, V. I., KUPCHENKO, G. V., GUZ', I. S., Physico-Technical Institute, Academy of Sciences Belorussian SSR; Ukrainian Scientific Research Institute of Metals; Institute of Problems of Machine-Building, Academy of Sciences Ukrainian SSR

[Abstract] A breakdown of Ni_3Al - Ni_3Nb specimens with 2x2-mm notches starts at the notch apex, where the main crack is formed. The main crack in specimens with a regular structure is propagated in transverse and longitudinal directions to lamellas. The main crack trajectory has a simpler configuration in specimens with a less regular structure. The propagation rate of the main crack (there are many branching and secondary cracks) in specimens with a regular and irregular structure is 100 - 1600 m/sec, with the average rate being 280 - 300 and 600 m/sec for regular and less regular structures, respectively. Two distinctive breakdown mechanisms are observed, the quasi-brittle and the quasi-viscous. The Ni_3Al phase breaks down according to the quasi-viscous mechanism, and the Ni_3Nb phase, according to the quasi-brittle mechanism. The breakdown time is longer for specimens with a regular structure, in comparison with specimens of a less regular structure. The stepwise rupture of the eutectic Ni_3Al - Ni_3Nb alloy is caused by a combination of cracks, the main crack and branching and secondary cracks. Figures 3; references 5: 4 Russian, 1 Western.

AN INVESTIGATION OF CHANGES IN THE POROUS STRUCTURE OF METALLIC TITANIUM IN THE PRESENCE OF A LIQUID PHASE

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 34-37
manuscript received 19 May 78

ALEKSANDROVSKIY, S. V., ZAKHAREVICH, A. A., and SANDLER, R. A., Leningrad

[Abstract] The test material consisted of sodium thermal titanium powders ranging from -0.18 to +0.6³ mm in size, which had similar characteristics to magnesium thermal titanium structures. Samples weighing 40 g were sintered in the presence of sodium and potassium chlorides, and also with the addition of titanium trichloride or metallic sodium at 3 wt.%, and magnesium at 30 wt.%. After leaching in a 1% solution of hydrochloric acid, characteristics of the metallic titanium obtained were measured by the argon heat desorption method. Results indicated that increasing the duration of sintering increased the yield of +0.5 mm particles. Increasing the temperature from 800 to 900°C had the same effect and also reduced the specific surface of the material obtained. Sodium and potassium chlorides had no effect on the titanium powder, but titanium trichloride and especially metallic magnesium were shown to cause the formation of a dense mass. The smallest content of chloride ions was found in samples sintered at 900°C in the presence of metallic sodium or magnesium. Figures 2; references 5: 4 Russian, 1 English.

ON THE NATURE OF THE SUPERPASTICITY OF MICROCRYSTALLINE MATERIALS

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 3-11
manuscript received 17 Nov 78

BOCHVAR, A. A., Moscow

[Abstract] The superplasticity of fine-grained metallic substances (grain diameters less than 10 microns) and the superplastic deformation of these materials are discussed with emphasis is on the unusual level of flexibility of such materials in comparison with other polycrystalline materials and on the absence of marked changes in grain dimensions under extreme deformation. The phenomenon is described partly in terms of the solution-precipitate mechanism of mass transfer in which recrystallization, spheroidization, coagulation of particles, and mass transfer between graphite and carbide phases are involved. The deformation temperature must be more than half the material's melting point, and the speed of deformation less than 10⁻¹/sec.

It is concluded that superplasticity is present only as a structurally sensitive property where there are large numbers of fine grains in the material, and where conditions permitting massive intergranular slippage are present. A constant diffusion curing process at a rate equal to the rate of defect formation is also a feature of superplastic deformation. References 8: 5 Russian, 3 English.

USSR

UDC 669.017:539.3

EVALUATION CRITERIA FOR THE EFFICIENCY OF MATERIALS HAVING THE SHAPE "MEMORY" EFFECT

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 125-129 manuscript received 10 Feb 78

PAVLOV, I. M., KALACHEV, I. B., GRANATKIN, YU. A. and MEKHED, G. N., Moscow

[Abstract] The key features of shape memory of metals were determined to be the relative ability to return to the initial shape, the magnitude of this tendency, and the energy utilized in the process. Mathematical formulas were established to measure these features, and were applied to intermetallic NiTi containing 54.8 wt.% nickel. After annealing at 450°C the 10 x 48 x 0.3--1.0-mm samples were deformed in arcs by amounts from 0.55 to 3.5%, then reheated. Results indicated that the optimum efficiency came at 2% distortion, after which shape memory declined rapidly. Figures 3; references 8: 4 Russian, 3 English, 1 German.

AN INVESTIGATION OF HIGH TEMPERATURE NITRIDING OF TITANIUM AND ZIRCONIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR. METALLY in Russian No 2, 1979 pp 186-192 manuscript received 29 Nov 77

VADCHENKO, S. G., GRIGOR'YEV, YU. M. and MERZHANOV, A. G., Moscow

[Abstract] Nitriding of titanium was conducted at temperature intervals between 1250 and 1620°C, while the temperatures for zirconium nitriding were between 1300 and 1830°C. Metallographic examination than was used to evaluate the formation of nitride phases on the metal surfaces. Test cut sections showed thorough saturation by nitrogen prior to the formation of a nitride coating. Analysis of the data received in nitriding of poly- and mono-crystalline titanium, and zirconium fibers, indicates that heat release occurs more rapidly with polycrystalline titanium; with zirconium, diffusion is involved in all heat release at initial stages. Variations in nitriding are related to the simultaneous formation of alpha- and beta- solid solutions in titanium, while with zirconium the dissolution of nitrogen in the metal occurs before the formation of the alpha-phase and nitride. Figures 7; references 8 (Russian).

EFFECT OF THE INCREASE IN THE LUMINOUS EROSION OF METALS UPON SIMULTANEOUS APPLICATION OF LASER HEATING AND ULTRASOUND

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 79 pp 28-32 manuscript received 28 Nov 77

AGEYEV, V. A., Vitebsk

[Abstract] Features of the application of laser heating in a combination with ultrasonic vibrations to metals are investigated. A neodymium-glass laser was used, and the frequencies of the ultrasonic vibrations were varied from 20 to 200 KHz. Aluminum, iron, lead, and brass were used as targets. Such combined application of laser heating and ultrasonic vibrations was found to display a number of features resulting in, e.g., improvements in aperture shape, a marked increase in the amount of eroded matter in the droplet and vaporous phases, greater depth of cratering, and greater intensities of emission of the spectral lines of the elements, especially of the lines of impurities characterizing the spectral composition of the specimen material. The extent of cratering and the amount of eroded matter are highly sensitive to variation in energy flux density and duration of exposure, purity of material, physico-chemical properties of material, power and frequency of the ultrasound, and the vibration amplitude of the specimen. The

established patterns can be useful to physical research and for technical purposes, e.g., in spectroanalytic practice or in laser-beam treatment of materials. The substantial effect of the process of the nucleation of centers of volume vaporization on the dynamics of the luminous and electrical erosion of materials is demonstrated. The possibility of formation of spontaneous cavitation processes upon exposure of material to pulsed heat fluxes with the density 10^6 - 10^7 Wt/cm² is assumed. The cavitation-explosive (geyser) model of the collapse of electrical conducting materials is qualitatively described. Figures 3; references 14: 13 Russian, 1 Western.

USSR

UDC 535.211

SPATIAL NONLINEAR PROBLEMS OF METAL HEATING BY LASERS

Moscow FIZIKA I KHIMIYA OBRABOTKI MATERIALOV in Russian No 2, Mar/Apr 79
pp 3-13 manuscript received 1 Mar 78

RYKALIN, N. M., UGLOV, A. A. and SMUROV, I. YU., Moscow

[Abstract] The nonlinear axisymmetric spatial problem of the heating of metals by lasers is examined with allowance for the temperature dependence of thermophysical coefficients and the absorption coefficient. A semi-bounded solid and a plate of finite thickness are considered. The solution of the problem is obtained by an analytic method involving the approximation of the temperature dependence of the adjusted thermal conductivity coefficient by a linear dependence for specific materials, such as copper and Cr-Ni austenitic steel and, ultimately, the construction of an iterative process to find the solution correct to a specified extent, with the first approximation already providing basic information on the characteristic parameters of the process. The presented algorithm can be used for the solution of the problems of heating of solids of varying geometry, e.g., spherical particles, with varied boundary conditions that allow for heat exchange with the ambient medium. This also applies to problems of the heating of solids by heat sources with various space-time distribution and by volume sources, which is of major interest to problems of laser, electron-beam, and ion effects on materials. Within the temperature range from room temperature to melting point the temperature dependences of the absorption coefficient and the thermal conductivity coefficient are approximated in linear form, while volume heat capacity is approximated in cubic form. Figures 3; references 16: 12 Russian, 4 Western.

EFFECT OF LOADING CONDITIONS ON THE CYCLIC BENDING STRENGTH OF D16T AND OT4-1 ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 4, 1979 pp 44-48 manuscript received 27 Feb 78

KUZ'MENKO, V. A., GOLOVANEV, YU. M. and MATOKHNYUK, L. YE., Kiev, Institute of Problems of Strength, Academy of Sciences UkrSSR

[Abstract] Owing to engine noise, stall, and air turbulence, D16T aluminum alloy and OT4-1 titanium alloy are exposed to considerable tensile and cyclic bending stresses when used as aircraft sheeting panels. In this connection, 1.5-mm-thick sheet specimens of these alloys were subjected to fatigue tests under varying loads with the object of estimating their durability. The tests were performed with the aid of various devices. An electrodynamic vibration stand was used for symmetric bending tests. An electromagnetic test stand was used for bending under tensile stress. Tests of specimens under acoustic loading with and without superposition of a static tensile stress were conducted on test stand in which a pneumatic siren generating narrow- and wide-band noise was used as the source of the excitation of flexural vibrations. All the tests were performed at 100--150-cycle loading frequencies. The tensile stresses applied in bending tests ranged from 8 to 40 kg/mm². The presence of stress concentrators in specimens of both alloys caused the same decrease of 36% in endurance limit for both alloys (decrease from 29 to 18.5 kg/mm² for OT4-1 alloy and from 12.6 to 8 kg/mm² for D16T alloy), but the effective coefficient of stress concentration for the OT-4 titanium alloy was higher (1.7) than for the D16T aluminum alloy (1.6); thus the OT-4 alloy displays a higher fatigue strength. It is shown that the linear summation hypothesis (linear summation of stress-induced damage) is a sufficiently accurate means of computing the durability of specimens exposed to acoustic loading, on the basis of the findings of harmonic loading tests involving the same static stresses. Figures 6; references 12 (Russian).

USSR

UDC 546.261+546.281

INTERACTION OF SILICIDES, GERMANIDES AND OTHER PHASES OF STRUCTURAL TYPE
AlS WITH CARBON

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 4, Apr 79 pp 658-662

SAVITSKIY, YE. M., YEFIMOV, YU. V., MIKHAYLOV, B. P., MOROZ, YE. A., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] A study is made of the influence of carbon on the structure, phase composition and transition temperature to the superconducting state of niobium and vanadium alloys in systems with carbon. The microstructure of cast and annealed alloys was studied and the phase composition was determined. Isothermal cross sections of the niobium corners of the ternary systems Nb-Sn-C and Nb-Al-C are presented. The changes in phase equilibria in these systems and of the superconducting properties of ternary alloys are analyzed as functions of the positions of the components in the Periodic Table. Figures 4; references 4: 2 Russian, 2 Western.

USSR

UDC 546.7/8.281:537.311

INFLUENCE OF COPPER ON THE STRUCTURE AND SUPERCONDUCTING PROPERTIES OF TRANSITION METAL SILICIDES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 4, Apr 79 pp 654-657

SAVITSKIY, YE. M., YEFIMOV, YU. V., FROLOVA, T. M., Institute of Metallurgy imeni A. A. Baykov, Academy of Sciences USSR

[Abstract] A study is presented of the structure and superconducting properties of alloys in the system V (Nb, Ta, Cr, Mo, W)-Si-Cu, rich in transition metals. The microstructure and phase composition of the alloys were studied in the cast, annealed, rapidly hardened and tempered states. Phase equilibria of silicides of vanadium and niobium with copper are studied in the temperature range from 800°C to the melting points, and isothermal cross sections of the ternary diagrams of the systems are presented. Figures 2; references 14: 8 Russian, 6 Western.

STUDY OF THE SYNTHESIS OF BORON NITRIDE AT HIGH TEMPERATURES

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 4, Apr 79 pp 602-604

PARKHOMENKO, V. D., KRASNOKUTSKIY, YU. I., ZADOROZHNIY, V. M., and ZHIGULINA, N. A., Dnepropetrovsk Institute of Chemical Technology

[Abstract] A study is made of the possibility of regulation of the properties of boron nitride powder obtained by means of a plasma, by changing the synthesis conditions. The product produced was a powder of hexagonal boron nitride with crystalline lattice parameters $a = 2.502$, $c = 6.65$ Å. The phase composition and crystalline lattice parameters remain practically constant throughout the range of modes used. However, such properties as bulk density and color change with the conditions of synthesis. Figures 3; references 7: 5 Russian, 2 Western.

USSR

SOME NEW EFFECTS DISCOVERED IN A STUDY OF REFRACTORY COMPOUNDS

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 4, Apr 79 pp 563-568

ANDRIYEVSKIY, R. A., Moscow Institute of Fine Chemical Technology imeni M. V. Lomonosov

[Abstract] A study was performed of the interaction of carbon and nitrogen with transition-metal alloys, particularly zirconium-based alloys. The experiments revealed significant redistribution of the metal components of the alloy under the influence of nonmetallic atoms. Macroredistribution over a distance of a large fraction of a millimeter was observed for the first time. This process allows the production of multilayer products of refractory interstitial phases. The phenomenon of redistribution is explained physically by the fact that when the nonmetallic atom is introduced to the lattice, a heterogeneous force field arises, forcing diffusion of the metal atoms at various speeds. Superplasticity of refractory compounds was also detected. This property must be considered in determining conditions for high-temperature use of products made of these materials. Finally, an increase in the strength characteristics of the material has been observed following irradiation. Figures 3; references 25 (Russian).

USSR

UDC 546.8/7.261+546-162

USE OF MATERIALS MADE OF CARBON AND REFRACTORY COMPOUNDS IN ENGINEERING

Moscow NEORGANICHESKIYE MATERIALY in Russian Vol 15 No 4, Apr 79 pp 590-594

KOSTIKOV, V. I. and DERGUNOVA, V. S.

[Abstract] A review is presented of the use of carbon-based materials and refractory compounds. Materials discussed include silicon-impregnated graphite, resistant to the effects of corrosive media and allowing an increase in the service life of many types of products such as seals, bearings and pump parts; boron-silicon-impregnated graphite, a solid solution of boron carbide in silicon carbide, which has high resistance to heat and oxidation. Molded materials made of carbon plus various refractory compounds can be used as the receiving element for laser radiation measurements, in electrolyzer scrubbers and as high-temperature electrodes.

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